

THE MURISTŪŠ PNEUMATIC ORGAN.

(*Al-urghan al-jāmi' li-jamī' al-aṣwāt.*)

Bairūt MS. (*Al-Mashriq*, ix.)

Frontispiece to the
Organ of the Ancients.

THE ORGAN OF : : : : THE ANCIENTS

FROM EASTERN SOURCES

(Hebrew, Syriac and Arabic)



BY

HENRY GEORGE FARMER, M.A., Ph.D.

Carnegie Research Fellow

WITH A FOREWORD BY

The REV. CANON F. W. GALPIN, M.A., F.L.S.

Hon. Freeman of the Worshipful Company of Musicians

WILLIAM REEVES
BOOKSELLER LTD.

83 CHARING CROSS RD.,
— LONDON, W.C.2. —

MCMXXXI

Dedicated to
Robert Sangster Rait,
C.B.E., M.A., LL.D.
The Principal and Vice-Chancellor
of The University of Glasgow.

Printed by The New Temple Press, Norbury Crescent, London, Great Britain.

Y 7832

Dec. 21-1931 Boken 15/6

FOREWORD.

WHEN I was invited by Dr. Farmer to contribute a foreword to his treatise on *The Organ of the Ancients*, I accepted the offer with great pleasure, partly because I considered it a privilege and also for the reason that I have for a long time been interested in the early history of the instrument, and more especially, in that of the water organ or hydraulis. During the years 1900-4, stimulated by the researches of M. Clément Loret¹ and Dr. Charles Maclean,² I was able, through careful retranslations of descriptions given by Heron, Vitruvius and (for the *scale* an anonymous classical author),³ to construct a working model of the *hydraulis*, taking as its design a representation preserved by a small statuette of the early part of the second century A.D. discovered at Carthage. There is no need for me to describe its details here, for illustrations and particulars of this organ have frequently been published, the readiest to hand being those set out under its name in Grove's *Dictionary of Music*. With the help of the late Mr. C. F. Abdy Williams,⁴ a life-long friend and recognised authority on

¹ *Recherches sur l'orgue hydraulique*. (Extr. from *Revue archéologique*, 1890.)

² *The Principle of the Hydraulic Organ*. (In *S.I.M.G.*, vi, 1906.)

³ *Anonymi Scriptio de Musica*: Ed. Bellermann, pp. 94-5.

⁴ The author of *The Story of the Organ*, and *The Story of Organ Music*.

Foreword.

Greek music, we were able to give renderings of original Delphic hymns with voice, *kithara* and *hydraulis* at a lecture in the Fishmongers' Hall, London.⁵ The organ with its manual of nineteen keys and three stops, came through the ordeal triumphantly, even in the solo work, and we afforded a practical demonstration of its true principles, dispelling some of the ludicrous theories about its construction which were commonly current. And now having reluctantly, but by the author's desire, said thus much about myself, I turn gladly from personalities to the work which Dr. Farmer is presenting to us.

As will have been observed, the writers consulted by me with reference to this once popular form of organ were those living about the commencement of our present era. From that time, or shortly after, there seems to stretch out a vast silence on the subject; the so-called "Dark Ages" rested like a pall over the scene; knowledge was confined to the few; men were fighters rather than thinkers; and though here and there come glimmers, reflected in Greek and Roman carvings and coins focussed for us by M. C.-E. Ruelle,⁶ M. H. Leclercq,⁷ and other writers in their published researches, they are not sufficiently clear to give the light we need or the guidance we desire on the upward path of the organ. What was happening to it during the eight hundred years and more ere Western Europe woke to new knowledge? What fresh inventions had been thought out? What new improvements added?

⁵ See my *Notes on a Roman Hydraulis*. (Extr. from *The Reliquary*, 1904, and *The Water-Organ of the Ancients and the Organ of To-day*. In *The Story of English Music*, 1904.)

⁶ *Dict. des antiquités grecques et romaines*, iii, art. "Hydraulis" (1900).

⁷ *Dict. d'archéologie chrétienne et de liturgie*, vii (1), art "Instruments de musique" (1926).

Foreword.

Yet, notwithstanding the devastating havoc of war, many of the records of the past and passing years were preserved for the day, when, in the Land of the Dawn there arose a brilliancy of intellectual power and scientific inquiry unparalleled save by that of our own schoolmen and gildmasters of the later Middle Ages. From the eighth to the thirteenth centuries this rich and refined culture prevailed over Nearer Asia, as indeed it had flourished there in art and handicraft more than four thousand years before. In those far distant days Sumerian and Semite had delighted in the development and consorts of their lyres and harps, flutes and drums, sistra and timbrels; and now, in newly founded Baghdād, their successors devoted their skill to the perfecting of the like art and practice of music and to the systematic translation of the finest treatises of Greek and Syrian writers obtainable.

Thus they built up a literary fame and constructive reputation which spread not only eastward, but westward to the great trade marts of Constantinople and Venice, and through northern Africa, to the shores of Spain, Cordova rivalling Baghdād in educational and technical prowess. In this way, during those years of western obscurity, the discoveries and devices of the centuries as they sped were preserved to us; but unfortunately in languages inaccessible to most. We have had, it is true, peeps behind the scenes. Since Ugolinus⁸ gave us his masterly versions in Latin of the writings of Hebrew rabbis, we have received, within the last hundred years, Kosegarten's rendering of the Arabic master Al-Fārābī,⁹ the work of

⁸ *Thesaurus antiquitatum sacrarum* (1744-69).

⁹ *Alii Ispahanensis liber cantilenarum magnus* . . . (1840 et seq.).

Foreword.

Kiesewetter,¹⁰ with more recent translations by German savants and descriptions by French writers of modern Arab music, which, however, is a different matter. Yet the many wonderful treasures lying behind the curtained door have remained practically untouched. For, in the unveiling of these valuable heirlooms of the art of music, it is not enough that the student should be a sound oriental scholar, well versed in the language of the old schools; he must also have the practised eye and sense of the antiquary and the trained ear and mind of the musician. It is in Dr. Henry George Farmer that we possess these three requisites happily and effectually combined.

I have for a long time been under an obligation to Dr. Farmer; for his first book (on military music), which is a well used volume on my bookshelf; for his later writings and many of his communications to learned societies, which are known far and wide; and, on this occasion, for his latest work, the pages of which he has kindly allowed me to scan.

I am sure that its readers will be most grateful to him for this new instalment of Hebrew, Syriac and Arabic musical lore in so convenient and comprehensive a form. Many will not be able to test his conclusions by their own intimacy with the languages of which he is a ready master: others, after due consideration, may hesitate to endorse in their entirety the deductions and suggestions he has made; but certainly all cannot fail to appreciate his scholarly translations.

When I had my *hydraulis*, I badly needed wind "regulators" between the bellows and the stabiliser or compressor, which would have prevented the vagaries of an

¹⁰ *Die Musik der Araber* (1842).

A Foreword.

unsteady blower. In the Mûristus treatise here brought forward by Dr. Farmer we have these "regulators."

We are also indebted to him for having traced the genealogy of the myth of the Hārūn al-Rashid organ in Europe, which is shown to have started with De Genlis. It is now as dead as it can be, and I am glad that he has given it the *coup de grace*. As for William of Malmesbury, Dr. Farmer's new translation is certainly "up to date" in its "hydrostatic force" (*acquæ calefactæ violentiam*), but it is quite legitimate as a derivative from *caldus*—"active or excited under pressure."

On the one hand thanking him for exposing absurd and untrustworthy statements, and on the other relying on the trustworthiness of his expert research, I wish to this refreshing and informing book, as it goes forth to the light of day, every success and good fortune. *Naharak sa'id.*

FRANCIS W. GALPIN.

Faulkbourne, Essex.

CONTENTS.

	PAGE
Foreword by the Rev. Canon F. W. Galpin, M.A., F.L.S.	vii
Introduction	xvii
CHAPTER I.	
The Term "Organ"	1
CHAPTER II.	
The Invention of the Organ	7
CHAPTER III.	
The Organ from Hebrew Sources	21
CHAPTER IV.	
The Organ from Syriac Sources	45
CHAPTER V.	
The Organ from Arabic Sources (The Pneumatic Organ) ...	54
CHAPTER VI.	
The Organ from Arabic Sources (Hydraulic Organs) ...	79
CHAPTER VII.	
The Organ from Arabic Sources (The Hydraulis) ...	119
CHAPTER VIII.	
The Arabian Organ in Europe	139
APPENDIX I.	
Scale of Arabic Measurements used in the Present Work ...	158
APPENDIX II.	
Herōn's Hydraulis	159
APPENDIX III.	
Kircher's Automatic Hydraulic Organ	165
Bibliography	168
Index	176
Errata	185

LIST OF ILLUSTRATIONS.

The Mürîştus Pneumatic Organ	<i>Frontispiece</i>
Plate 1.—The Archimedes Automatic Wind Instrumentalist		<i>facing p.</i> 81
„ 2.—The Mürîştus Hydraulis	<i>facing p.</i> 129
Fig. 1.—The Mürîştus Pneumatic Organ	<small>PAGE</small> 71
„ 2.—The Archimedes Automatic Wind Instrumentalist		81
„ 3.—The Apollonios Automatic Hydraulic Organ. Showing the mechanism of the water-wheel cistern	82
„ 4.—The Apollonios Automatic Hydraulic Organ. Showing the two valves	83
„ 5.—The Apollonios Automatic Hydraulic Organ. Showing the two air-compressing cisterns	84
„ 6.—The Apollonios Automatic Hydraulic Organ. Showing the wind-pipes	85
„ 7.—The Apollonios Automatic Hydraulic Organ (Reconstructed)	86
„ 8.—The Banū Mūsā Automatic Hydraulic Organ (Re- constructed). Showing the three cisterns	99
„ 9.—The Banū Mūsā Automatic Hydraulic Organ (Re- constructed). Showing the recording barrel	101
„ 10.—The “Kitāb Al-Siyāsa” Hydraulis	125
„ 11.—The “Kitāb Al-Siyāsa” Hydraulis	126
„ 12.—The “Kitāb Al-Siyāsa” Hydraulis	126
„ 13.—The Mürîştus Hydraulis	134
„ 14.—The Herōn Hydraulis	162
„ 15.—The Kircher Automatic Hydraulic Organ	<i>facing p.</i>	165
„ 16.—The Schott Automatic Hydraulic Organ	<i>facing p.</i>	167

INTRODUCTION.

"*Ghubār ul-'amālī khairun min za'farān il-'uṭlātī.*"

"The dust of labour is better than the saffron of idleness."—
Arabic Proverb.

QUITE a regiment of historians have already paraded before us the alluring and fascinating story of the "King of Instruments," and one can therefore presage the interrogation being put, "Why add to the file?" The answer is that the present work does not profess to be a history of the organ, but just simply a contribution towards a particular provenance and period of its history, *hitherto unwritten or imperfectly known.*

Whilst most of the material offered will probably be quite new to the majority of readers, part of the Hebrew-Aramaic data from the Talmud and elsewhere, has long been known to historians. Yet, truth to tell, not since Ugolinus, in the eighteenth century, has any serious attention been paid to this rather important source. Ugolinus collected the most significant writings on the music of the Jews, with Hebrew texts, in his *Thesaurus antiquitatum sacrarum* (1744-69). Historians have neglected him, or, at any rate, have not taken advantage of his monumental work. Of course, Ugolinus wrote in Latin, and that may have repelled inquirers. For the first time the present work gives those interested in the question an *English translation of all the known references to the ancient organ in Hebrew-Aramaic literature.*

Introduction.

In regard to Syriac literature, the materials concerning the ancient organ are scanty. These, however, have also been translated into English, as they do not appear to have been known in this way before, if, indeed, they have ever been noticed.

More important is the Arabic literature, together with the few extracts from Persian and Turkish writers. Much of this is from manuscript sources hitherto untouched. One may even make bold to say that some of the data brought forward in the present work ought to make estimable material for future historians of the organ. The primitive *pneumatic organ* described in the Arabic treatise entitled *The Comprehensive Reed-Pipe Organ*, attributed to Mürîşîus, is certainly the earliest example of its kind known to us, and historians have hitherto only surmised the existence of such an instrument.¹ In the Arabic treatise on the *hydraulis*, attributed to Mürîşîus, we have, for the first time, a specification, together with designs, which, with the help of the descriptions of Herōn, Vitruvius, and the Carthage model, ought to be of material assistance to the successors of the Rev. Canon Galpin and the late Dr. Charles Maclean, when a real history of the instrument comes to be written.

Indeed, I believe that serious consideration deserves to be given to the opinion, which I have hazarded, that the Mürîşîus treatise on the *hydraulis* may be the actual work written by Ktēsibios, the *inventor* of the *hydraulis*, or an adaptation of it.

Grove's *Dictionary of Music and Musicians* (third edition, iii, 736) says: "*The Organ of the Ancients: From Eastern Sources*, . . . by Dr. Henry Farmer (in the press,

¹ *Encyclopædia Britannica* (eleventh edition), xx, 266.

Introduction.

1926), is looked forward to as an authoritative treatment of the subject." This statement is likely to cause confusion in the future so far as dates are concerned, as may be seen from a question asked in the *Musical Times* (1928, pp. 735-6, 833), and it seems advisable, therefore, that I should explain why a work that was "in the press in 1926" was not published until 1930.

The present work was completed in 1924, and early in 1925 it passed into the hands of Mr. William Reeves for publication. Shortly after this, I received a letter from Professor Dr. Eilhard Wiedemann, of Erlangen University, congratulating me on my *Arabian Influence on Musical Theory*, which had appeared in the January issue of the *Journal of the Royal Asiatic Society*. Correspondence followed, in which I informed him that I had completed a book on *The Organ of the Ancients: From Eastern Sources*, when, to my surprise, I learned from him that the Banū Mūsā and Mürîşîus treatises had been translated into German by himself and Professor Dr. Friedrich Hauser in a centenary volume and in a periodical publication respectively.²

Although the Mürîşîus translations had been made in 1918, even Baron Carra de Vaux appears to have been unaware of the fact, since, in his work, *Les penseurs de l'Islam* (1921), he expressed himself as follows about these Mürîşîus documents: "Ces textes évidemment ne sont pas très faciles; et les figures qui les accompagnent dans les manuscrits sont parfois plus décevantes qu'utiles. Ils sont au reste peu nombreux; et il serait désirable de les étudier et les traduire ensemble, afin d'en

² *Centenario della Nascita di Michele Amari* (1909). *Archiv für die Geschichte der Naturwissenschaften und der Technik*, viii (1918).

Introduction.

*tirer tout le parti possible.*³ It was, indeed, the very words of Baron Carra de Vaux that originally led me to plan the present work, and it came therefore as a great surprise to me when I found that I had been forestalled in the translation of these treatises.

It was my intention to immediately withdraw the manuscript of my book from the publishers, but I deferred to the persuasion of two eminent scholars who had read the manuscript, and urged publication because of the other original material brought forward in my book, and because the Banū Mūsā and Mūrīṣṭus documents would be in English translations. In 1926, on the eve practically of the work being sent to the press, I decided not to publish, as, in spite of the labour bestowed on the work, I did not feel the same interest in publishing since I had learned of the German translations above alluded to.

Mentioning the matter one day to Mr. A. S. Fulton, M.A., of the British Museum, to whom I am indebted for many courtesies, I learned that the Museum had acquired an exemplar of the Mūrīṣṭus treatises. In my previous work, the Bairūt MS. of Mūrīṣṭus, as found in the *Mashriq*, had been used. The texts were faulty, and I was far from being satisfied with the translations. Professor Dr. Wiedemann had the benefit of a Constantinople MS., although not at first hand, as well as the *Mashriq* text.⁴ A perusal of the British Museum copy soon convinced me that, in spite of *lacunæ*, this was perhaps the best. This decided me to reconsider the publication of

³ ii, 180. He had himself given a part translation of the *hydraulis* document in the *Revue des Etudes grecques* (1908).

⁴ Professor Dr. Wiedemann did not himself use the Constantinople MS. Professor Dr. Bergstraesser, then at the University of Constantinople, compared the *Mashriq* text with the MS. and noted the variations, which were communicated to the former.

Introduction.

my book, and with the British Museum MS., which had not hitherto been used, I was able to go over the ground afresh, and it is from the latter manuscript that the present translations of the Mūrīṣṭus treatises have been made.

As for the Banū Mūsā treatise, I may say that Professor Dr. Wiedemann's work was not a complete translation. Much of it was an abridgment. This was an additional reason for including this treatise in a complete translation.

It is now 1930, and the printing of the book is nearing completion. I have just received through the courtesy of the authoress, Mrs. Helen Robbins Bittermann, of Columbus, Ohio, U.S.A., two articles published by her in 1929 in *Speculum*, the journal of the Mediæval Academy of America, on (1) *Hārūn ar-Rashīd's Gift of an Organ to Charlemagne*, and (2) *The Organ in the Early Middle Ages*. The first of these articles reminds me that in 1927 I sent to Mr. O. G. Sonneck, the editor of the *American Musical Quarterly*, an article entitled *The Arabian Organ in Europe*, which was, in fact, a résumé of the last chapter of the present book. The article did not appear, and its receipt was not even acknowledged. Had that article appeared, there would have been no necessity for that of Mrs. Bittermann's, since the latter simply traverses the ground which had already been covered by me, and I had already shown in 1926 (*Journal, Royal Asiatic Society*, p. 496) that the Hārūn-Charlemagne organ was a myth which could not be traced beyond Madame De Genlis.

In her first article Mrs. Bittermann quotes from some of my writings, and says (p. 216): "Farmer erroneously assumes that the Arabs reintroduced the organ into

Introduction.

Europe." Reference to my *Arabian Influence on Musical Theory* (p. 5), *Historical Facts for the Arabian Musical Influence* (pp. 295-7), and the present work (p. 154), will establish that it is actually Mrs. Bittermann who has "erroneously assumed." It was revival of interest in the *hydraulis*, not in the *organ* (pneumatic organ) in Europe, that I suggested was due to the Arabs. My critic says that the organ was "not indigenous to the Arab," and for authority for her statement she refers her readers to F. Salvador-Daniel's book translated by me under the title of *The Music and Musical Instruments of the Arab* (1915) and to the article on "Music" in the *Encyclopædia of Islām*. So far as Salvador-Daniel or myself is concerned, there is no authority for the statement to be gleaned from us. As for her second reference, the article in the *Encyclopædia of Islām* has not yet appeared!

In concluding this "Foreword" I would like to say that in several places reference is made to the *Yūnāniyyūn* and *Rūm*, who have been made to stand for the ancient Greeks and the Byzantines respectively. It ought to be borne in mind, however, that the terms sometimes refer to the Byzantines and Romans respectively.

A verbal translation of the Arabic documents has been aimed at. In some instances it may be considered that the results have been rather too verbal. My desire has been, however, to convey as faithfully as possible not only the style of the original Arabic, but also the processes of Arabian thought.

The transliterations from the Arabic have been made in accordance with the system approved by the Royal Asiatic Society, and now used generally in most English-speaking countries. There are a few modifications, including the omission of the ligature or logotype for "th,"

Introduction.

"dh," etc. In Hebrew and Syriac, whilst the conventional method has been followed, there are occasional inconsistencies. The quantities and diacritical points have been omitted in these languages. Whenever I have used the name of a musical instrument or a technical word, I have invariably given the Semitic word in parentheses, but in the *singular*, even when the text demands otherwise, rather than confuse the reader by the use of the *dual* or *plural*.

Finally, I have to express thanks and obligations in several quarters. First, there is a debt of gratitude to my old teacher, the late Dr. T. H. Weir, Lecturer in Arabic at Glasgow University, to be acknowledged. The whole of the Hebrew and Syriac translations are practically his, whilst his help in other directions was considerable. I have also to speak of my indebtedness to Professor D. S. Margoliouth, F.B.A., of Oxford, who read my MS. in its earlier form, and encouraged me to publish, in spite of the disappointment already alluded to. To Professor W. B. Stevenson, D.D., and the Rev. Alexander Moffatt, B.D., of Glasgow, I must record my thanks for generously reading my proofs, and offering suggestions, whilst I have also to acknowledge a debt for several kindnesses to Dr. J. M. Clark, M.A., and Mr. Adam Henderson, B.Litt., of Glasgow University. Finally, I would like to mention that I am indebted to the Carnegie Trust for its beneficence in lightening the financial burden which many of us engaged in research of this nature find a serious impediment.

HENRY GEORGE FARMER.

Glasgow, *September*, 1930.



CHAPTER I.

THE TERM "ORGAN."

"And his brother's name was Jubal; he was the father of all such as handle the *harp* and *organ*."—*Genesis* iv, 21.

THE use of the term "organ" in the Bible¹ has, for many centuries, been the cause of much ink being spilt by historians of music. To them, "organ" meant the "mechanically wind-fed instrument," and for the translators of the Bible to equate the Hebrew word '*ugab*' with the English word "organ," simply meant to the historians that the translators did not know any better, since the '*ugab*' has generally been recognised as a "pipe" or "wood-wind" instrument. Yet it is quite clear that the translators of the Bible were fully justified in what they did. Ælfric, Wyclif, Tyndale, Coverdale, and the compilers of the "Great Bible," had all written "organ" before the appearance of the authorised version of 1611. The work of these scholars was certainly based on the Latin Vulgate, for the greater part, and in this latter, *organum* = '*ugab*.'² We must bear in mind, however, that

¹ *Genesis* iv, 21. *Job* xxi, 12, xxx, 31. *Psalms* cl, 4.

² In the Greek Septuagint, *organon* = '*ugab*' only in *Psalms* cl. In *Genesis* and *Job*, it equates with *psalterion* (transposed with *kithara*) and *psalmos* respectively. The additional *Psalms*, cli, certainly has *organon*, but we do not possess the Hebrew of this

The Organ of the Ancients.

"organ" had stood for a "pipe" in English from Anglo-Saxon times⁵ down to the days of Shakespeare⁴ and Milton.⁵ The usage had come with the Latin tongue, and we find in Quintilianus (d. 118 A.D.) that *organum* meant a *pipe*.⁶ With the Greeks also, as may be seen in Telestes (d. 400 B.C.), *organon* had a similar connotation.⁷

In modern Hebrew, the word 'ugab stands for our present *organ* or *piano*,⁸ but we cannot argue from this that the same meaning was implied in biblical times. In fact, there are reasons for believing that the modern Hebrew connotation is due to the influence of the Septuagint and Vulgate. Admitted that 'ugab equates with *hydraulis* in the *Talmud* and in the *Targums of the Hagiographa* (third to ninth century),⁹ yet this scarcely proves anything more than the fact that the Jews of this period knew of the *hydraulis*.¹⁰

Returning to the question whether "organ" stood for a "pipe," there is corroboration from Muslim sources that

psalm. In Golius (*Lexicon Arabico-Latinum*), qītār = 'ugab, *organum* in Gen. iv, 21. See also, *Targum Arvi. Die arabische interpretation des Pentateuchs von Rabbi Saadia Hagaon*. . . von Rab. J. Schwarzstein (Frankfurt a/M., 1886), page 18, and ii of text.

⁵ *Archiv für Studium der Neueren Sprachen*, xevii, 32, 17. *Bibliothek der Angelsächsischen Prosa*, iii, 136.

⁴ *Hamlet*, iii, 2.

⁵ *Paradise Lost*, vii, 596.

⁶ Quintilianus, 11, 3, 20.

⁷ Bergk, *Poetae Lyrici Græci*.

⁸ *Jewish Encyclopædia*, ix, 432. In the same way, *psanter* stands for "pianoforte," but this does not help us to interpret the instrument in *Daniel*, iii.

⁹ *Talmud Yrushalmi*, Sukkah, v, 6. Jastrow, i, 365.

¹⁰ Some commentators say that the words "stringed instruments" and "organs" in *Psalm*, cl, 4 (A.V.), which translate *minim* and 'ugab, are misplaced, and that *minim* should more properly translate "organs." In the second introduction to Mendelssohn's translation of the *Psalms*, this notion is followed.

The Term "Organ."

this was accepted in the East. The old Persian lexicon entitled the *Burhān-i qāfi* says:¹¹

"Some say organ (*urghanun*) is a translation of 'pipes' (*mizmār*), meaning all instruments of blowing," and as late as the Turkish writer, Evliyā Chelebī (d. c. 1679), the word organ (*urghanūn*) is used in this sense.¹²

Besides meaning a "mechanically wind-fed instrument" as well as a "pipe," the term *organon* or *organum* stood, with the Greeks and Romans, for an "instrument of many strings," and also for "any musical instrument." As an "instrument of many strings," the term *organon* is used by Plato (d. 347 B.C.)¹³ and Aristoxenos (b. c. 354 B.C.). The oft-quoted passage in the *Deipnosophistae* of Athēnaios (fl. 220 A.D.), in which the chatty author quotes Aristokles asking "whether the *hydraulic organ* (or *hydraulis*) is a stringed (literally 'beaten') or a wind instrument,"¹⁴ appears to be explicable only by taking cognisance of the wide use of the term *organon*.

Athēnaios says that the master musical theorist did not know of this point. The work of Aristokles has not come down to us, but we know something of the writings of Aristoxenos. Paul Tannery has shown that Aristokles was contemporaneous with Apollodoros, and must therefore be placed in the second century B.C.¹⁵ Aristoxenos however, lived, in all probability, before the *hydraulis* was invented, so that he could scarcely have been in any dubiety as to its category. We know that in one place Aristoxenos refers to the *trigonon* ("an instrument of many strings") as an *organon*, and this might account for

¹¹ *Burhān-i qāfi*, s.v.

¹² Evliyā Chelebī, *Narrative of Travels*, i, ii, 135.

¹³ Plato, *Repub.*, 399, c.

¹⁴ Athēnaios, iv, 75.

¹⁵ Tannery, *Athénée*, 26.

The Organ of the Ancients.

the query mentioned by Athēnaios, who may have had the word *organon* in mind when he wrote the above passage. That Aristokles should ask the question is quite allowable because what he was probably referring to was not the *hydraulis*, but a *hydraulic organ* of a different kind, which made figures play wind, string and percussion instruments.

The term *organum* was understood by mediæval Latin writers to stand for something similar, since we read: *Psalterium Rotta is genus organi*.¹⁶ According to the Irish glosses, *organa* stood for *timpanum* and *chithara*.¹⁷ Corroboration also comes from Syriac sources since we know from Isho' bar Bahlul (fl. 963) that the term "organ" (*urghanun*) was used for two kinds of musical instruments, a "mechanically wind-fed instrument" and an "instrument of many strings." Here is what he says:¹⁸

"There are two kinds of organ (*urghanun*), of which the first has the shape of a weaver's frame, supplied with many strings, and its sounds can be heard seven stadia distant."

Elsewhere we read that this instrument possessed ten strings. From Arabic sources we may quote from the historian, Al-Mas'ūdī (d. c. 956), who uses material from an earlier writer, Ibn Khurdādhbih (d. c. 912). He speaks of the Byzantine *urghan* as an instrument of "sixteen strings," whilst the "mechanically wind-fed instrument" is termed the *urghanun*.¹⁹ In the eleventh century *Glossarium Latino-Arabicum*, edited by Seybold,

¹⁶ *Mon. Germ. Hist.*, ii, 101. See Boëthius, *De musica*, i, 34.

¹⁷ Stokes and Strachan, *Thesaurus Palaeohibernicus*, i, 298.

¹⁸ Payne Smith, 91.

¹⁹ Al-Mas'ūdī, viii, 91-2. Farmer, *Studies in Oriental Musical Instruments*, page 56. Cf. *Byzantine Musical Instruments*, 4.

The Term "Organ."

the term *organica* equates with "possessed of many strings" (*dhū awtār kathīra*),²⁰ which reminds us of Plato's *organon polychordon*.¹

The term *organum*, used in general for "any musical instrument," may be found in Cato (d. 149 B.C.),² Lucretius (d. c. 50 B.C.),³ Julius Firmicus (fl. 340 A.D.),⁴ and St. Augustine (d. 340 A.D.).⁵ The last named says on this point:

"*Organa* is the word used for all instruments of music. Not only is that called *organum* which is large, and is inflated by means of bellows, but whatever is adapted to singing, and is corporeal, which he who performs uses as an instrument, is called *organum*."

In another passage the same author says:⁶

"This instrument to which bellows are applied, is called by the Greeks by another name, and its being called *organum* is rather a conventional Latin usage."

This passage is rather interesting since it might be hazarded that the "other name" used by the Greeks was *hydraulis*. On the other hand there are two passages quoted by Ruelle which supply perhaps a better clue for this "other name." Here are the two passages:⁷

"(*Organon*), the 'flute-like,' of brass, which is called the *megiston organon* (greatest organ), *cheirorganon* (hand organ)."

"Those which are called 'organs,' especially with us at present, the ancients called the *plinthion achordon*

²⁰ Seybold, 357.

¹ Plato, *Repub.*, 399, c. Cf. Julius Pollux, iv, 9, 5.

² Cato, *Non.*, 77, 9.

³ Lucretius, 3, 132.

⁴ Firmicus, 3, 14.

⁵ St. Augustine, *Comm. Psalm*, lvi, 16.

⁶ St. Augustine, *Comm. Psalm*, cl, 7.

⁷ Ruelle, 312. See Leclercq, 1177-8.

The Organ of the Ancients.

(stringless *plinthion*), and the *plinthion auleichon* (flute-like *plinthion*)."

It was evidently the plinth-like form of the organ-case, or the pedestal which supported it, which led to this name being given to the organ by the Greeks.

In Western Europe during the Middle Ages, we have the term *organum* standing for a particular kind of musical composition. On this question the Persian *Burhān-i qāṭi*⁸ seems to point to a similar procedure:⁸

"Others say that when a thousand men, old and young, all together, with different sounds, sing to one another something, that state of things they call *urghanūn*."

Whether the term *organum*, which stood for a certain species of composition, came into use owing to the fact that this kind of music was played on the instrument called the *organum*, is not easy to say. At the same time, such a procedure obtained, it would seem, in Syria, in regard to the *hydraulis*. In Syriac, the latter instrument was called the *hedhrula*, and the Syriac lexicographer, Isho' bar Bahlul (fl. 963) says:⁹

"*Hydraules* are also the tunes played upon them [the *hydraules*]." The Arabic commentary on the passage says that the word means, "The music (*ghinā'*) in them [the *hydraules*], or the player (*mughannī*) on them."

Elias bar Shinaya (b. 975) says:¹⁰

"*Hydraules* are kinds of playing that the *mukhannathūn*¹¹ play."

⁸ The *Burhān-i qāṭi* gives an alternative reading: "A concert of seventy girls, all singing the same thing." Professor Margoliouth has kindly suggested to me that probably someone derived the word from the Armenian *erg* = "song," and *noin* = "the same."

⁹ Payne Smith, 977.

¹⁰ *Ibid.*

¹¹ The *mukhannathūn* were a debased class of men. See my *History of Arabian Music*, pages 44-5.

CHAPTER II.

THE INVENTION OF THE ORGAN.

"Some say this and some say that, but Allāh alone knows the truth."—*Arabic Byword*.

THE organ that we now have to consider is the instrument which we Westerners of modern times know by this name. It is the "mechanically wind-fed instrument" known in two forms, (1) the *pneumatic organ*, and (2) the *hydraulic organ*. This nomenclature is certainly rather misleading, but it has been in use so long that it is scarcely worth while at this time of day to seek more precise terminology. Both organs are, strictly speaking, pneumatic, i.e., they are made to speak by means of air pressure. The real difference between them is in the method by which the wind supply and wind pressure stabilisation are obtained. Further, two principles are involved in the hydraulic organs. In one, the wind supply is furnished by a *hydraulic air compressor*, as in the Banū Mūsā instrument. In the other, the wind supply comes from bellows or pistons, whilst the water only plays the part of stabilising the pressure. This is a *hydraulic pressure stabiliser* as in the *hydraulis*.¹

¹ Throughout this work, the term *pneumatic organ* is used in reference to all mechanically wind-fed instruments where the wind supply and wind pressure stabilisation are furnished by bellows or pistons. The term *hydraulic organ* is used for any instrument

The Organ of the Ancients.

Some writers look upon the *hydraulis* as the earlier type, but this theory is wholly untenable, since there cannot be any doubt that the pneumatic organ has the prior claim. How and where this latter originated, have been variously speculated upon. Two names occur in the Bible as "inventors" of the organ. They are Jubal and David. Added to this we have the claim of the Roman Church that St. Cecilia has this honour.

According to *Genesis* (iv, 21), Jubal "was the father of all such as handle the *harp* and *organ*." So runs the English "Authorised Version" and almost every other translation, where "organ" stands for the Hebrew *'ugab*, a word which, as we have already seen, represents an instrument of the wood-wind family.

David's claim as an organ inventor has its authority in the additional *Psalms* of the Septuagint. Here we are told that David "fashioned" an organ (*organon*), but since we have no Hebrew original of this part of this psalm, we cannot say which type of instrument is intended, especially when we take into consideration the various words which *organon* stands for in the Septuagint.² David had an inordinate reputation among the Jews in matters musical,³ and he was recognised as an inventor of musical instruments quite apart from the testimony of this psalm.⁴

Rabbinical lore has heightened this esteem,⁵ and even the Arabs became infatuated with this laudation of his

where the wind supply comes from a hydraulic air compressor, whilst the term *hydraulis* is reserved for the instrument furnished with a hydraulic pressure stabiliser.

² See *ante*, page 1.

³ *I Samuel*, xvi, 18. *II Samuel*, vi, 5. Josephus, vii, 12.

⁴ *Amos*, vi, 5.

⁵ *Talmud Yrushalmi*, Berakhoth.

The Invention of the Organ.

musical gifts.⁶ In this connection there is a Muslim tradition which runs:⁷

"The organ (*urghanūn*) is an old invention, and it is said that formerly David accompanied his psalms with it. . . . David invented this instrument (at Edessa)."

The St. Cecilia claim is almost as legendary. This "Patron Saint of Music" lived in the second century A.D., long after the invention of the organ. Some people have suggested that it is merely the small portable organ that is referred to here. So far the imagined inventors of the organ.

Although history tells us nothing about the inventor of the organ, we can be reasonably sure of the process of its invention. Kathleen Schlesinger, in her *Researches into the Origin of the Organs of the Ancients*, says that the "essentials" in the instrument are: "(1) a set of reeds or pipes of various lengths; (2) a contrivance for supplying the pipes with wind and thus enabling them to speak; (3) a system for controlling the distribution of the supply of wind separately to each of the several pipes."⁸ The *first* had its prototype in the ordinary reed-pipe and Pan-pipes. The *second* was suggested by the bagpipe and the bellows. The *third* was a question of mechanics. All these requisites may be traced back to the very dawn of civilisation in Babylonia-Assyria and Egypt. When it was precisely that the "restless intellect of man" conjured all these "essentials" together in a primitive organ, we do not know. All that we can be sure of is that it was long anterior to the fourth century B.C., a period when

⁶ *Qur'ān*, xxi, 79; xxxiv, 10; xxxviii, 17. *Kashf al-mahjūb*, 402. Al-Tabarī, i, 423.

⁷ Evliyā Chelebī, i, ii, 226. ⁸ Schlesinger, *Researches*, 169-70.

The Organ of the Ancients.

we have definite knowledge of organs in an advanced stage of construction.

The late Dr. Charles Maclean, who wrote an able essay on the ancient *hydraulis*, postulates three distinct stages of organ blowing. Under this heading he says:⁹

"The *first* stage in supplying it (the wind) is, when a man either steps on to a blast-bag and so puts his weight, or else applies his hands thereto and so puts his muscular force, to expelling the enclosed air at an increased pressure; he then gives wind directly proceeding from his own exertions, and so varying in pressure, to the speaking pipe. The *second* stage is when natural inanimate weights are fixed at the summit of the slanting top of a framed blast-bag ('diagonal bellows'), and the man's action consists in periodically lifting the weighted frame by lever, pulley, etc., so that the weights can act; here it is a natural inanimate weight which gives unvarying pressure of wind to the speaking pipe, and the only drawback is stoppage of continuity of supply at the moment the weights are raised—which obviated by multiplying and alternating the weighted blast-bags. The *third* stage is when the weights are placed on the flat top of a separate distensible and collapsible air-reservoir ('horizontal bellows'); then the action is as before, only that the feeder being now a distinct apparatus and feeding through a non-return valve, all lack of continuity also is avoided. These three stages have always (? H. G. F.) overlapped, and been thoroughly concurrent with each other."

This classification is, on the whole, fairly satisfactory, but, it has already been pointed out,¹⁰ there may have been an earlier application of the methods of the *first*

⁹ Maclean, 211.

¹⁰ Schlesinger, *The Organ*, 266. Matthews, *A Handbook of the Organ*.

The Invention of the Organ.

stage, where the blast-bag was inflated *by the mouth*. That this conjecture is correct, will be demonstrated presently *from Arabic sources*.

About the fourth century B.C., another method of "winding" the organ was introduced. This was the first *hydraulic organ*. In this the air was forced into the sounding-pipes by the flow of water, and it is this instrument that has been confounded with the *hydraulis*, a totally different instrument. Warman, for instance, tells us that Plato is credited with the invention of the *hydraulis*, but that the attribution is false because "this organ (of Plato's) was not a real hydraulicon (= *hydraulis*), for the water was employed by Plato to cause its gravitating power to set in motion an ordinary fold-made or pneumatic bellows."¹¹ This description of Plato's instrument is rather fantastical. Athēnaios is the sole authority, and his words imply no such interpretation. Athēnaios distinctly states that "Plato had an idea of this type of instrument, since he had made a night timepiece something like a *hydraulis*, being similar to a large *klepsydra*, and the *hydraulis* [i.e., *hydraulic organ*] seems to be a kind of *klepsydra*."¹² The Plato timepiece was clearly a *klepsydra* which sounded the hours by means of a flue-pipe or pipes through the action of hydraulic air compression.¹³

The Plato claim for the "invention" of the organ is also to be found in the Persian *Burhān-i qāṭi'*:¹⁴

¹¹ Warman, 38.

¹² Athēnaios, iv, 75.

¹³ For a discussion on the Plato instrument, see Diels, *Über Platons Nachtuhr* (Sitz. der K. P. Akad. der Wiss., 1915, page 824).

¹⁴ *Burhān-i qāṭi'*, s.v. From Greek sources we know little or nothing of Plato's musical abilities, but from an Arabic author, Ibn al-Qifṭī, we learn that Plato studied music in his youth and wrote on the subject.

The Organ of the Ancients.

"The organ (*urghanun*, *urghanūn*) is that instrument which the Europeans (*Rūmiyān*) play, and Plato is the inventor of it."

The authority for this is probably an Arabic one, although I have been unable to trace it.

Aristotle (fl. 344 B.C.) is also mentioned as the inventor of the organ, but only by Muslim writers, so far as I am aware. The famous scientist, Fakhr al-Dīn al-Rāzī (d. 1209) says in his *Jāmi' al-'ulūm*:¹⁵

"The world-master Aristotle (Aristāṭālīs) arrives, and the organ (*urghanūn*) is made."

Three hundred years later, the Turkish bibliographer, Ḥājji Khalīfa (d. 1658) tells a similar story in his *Kashf al-zunūn* ("Doubts Cleared up"). He says:¹⁶

"After him [Pythagoras] other wise philosophers added to what he had invented, until the turn came to Aristotle, and he conceived and constructed the organ."

How Aristāṭālīs, Aristāṭālīs, or Aristū, as he is variously designated by Muslim writers, came to have this "invention" tacked on to his name is not easy to say.¹⁷ Classical authors, whose works have come down to us, do not mention it. Aristotle's *Mechanika* (a pseudograph), known in Arabic as the *Kitāb al-ḥiyāl*, was possibly one of the earliest works on mechanics known to the Arabs. This may have led them to ascribe so novel a contrivance as the organ to the Stagirite. Further, the name Aristū could easily be confounded with Aristūn (Mūristūs), who is claimed to have been the inventor of the organ or a writer on the subject of its construction, as will be shown later.

¹⁵ Fakhr al-Dīn al-Rāzī, folio 154 v. ¹⁶ Ḥājji Khalīfa, vi, 258.

¹⁷ The *klepsydra* was certainly known in Aristotle's day. See *Problems*, xvi, 8.

The Invention of the Organ.

Archimedes (d. 212 B.C.) is mentioned by Tertullian as the inventor of the *organum hydraulicum*.¹⁸ This statement has led Warman to assert that "the first or true inventor of the actual hydraulic organ (= *hydraulis*) was undoubtedly the celebrated Archimedes."¹⁹ The facts of the case are such, however, that this certainty will not bear close scrutiny. One may perhaps say quite safely that the *hydraulis* can scarcely be older than Archimedes, seeing that he was the creator or systematiser of the science of hydrostatics, but this alone hardly warrants us in concluding that he was the "inventor" of the *hydraulis*.

Most historians of the organ, from the time of Vossius (1673)²⁰ to Degering (1905),¹ have repudiated the Tertullian claim. Probably the repudiation is quite proper, if the *hydraulis* itself is meant, although it would seem that Archimedes may have some claim as the inventor of another type of *hydraulic organ*. A Byzantine writer named Zosimos (fl. 408-50 A.D.) has a significant phrase which may be turned to account. It runs: τὰ πνευματικὰ Ἀρχιμήδους.²

The Arab polygraph Al-Jāḥiẓ (d. 868) also mentions Archimedes in such a way that might suggest some reason for the claim. He says: "What a distance! Archimedes (Arshakānus) to Mūristūs!"³ This Mūristūs, as we shall learn presently, was the name of a Greek savant who is claimed in Arabic works to have been the inventor of the *hydraulis*, and a writer of works on organ construction. Strange to say, Archimedes is credited by the Arabs with the invention of the *klepsydra*,⁴ and we have seen that the

¹⁸ Tertullian, *De anima*, xiv. ¹⁹ Warman, 38.

²⁰ Vossius, 107.

¹ Degering, *Die Orgel*.

² Ruelle, 312.

³ Al-Jāḥiẓ (Cairo edition), 133, 143.

⁴ Carra de Vaux, *Notice sur deux mss. arabes*, 295.

The Organ of the Ancients.

klepsydra has been confused with the *hydraulic organ* or *hydraulis*.

There exists in Arabic a treatise attributed to Archimedes which describes a *klepsydra* in which a small flue-pipe (*ṣaffāra*) is sounded by hydraulic pressure, whilst another treatise of his deals with an automatic wind instrumentalist (*ālat al-zāmīr*) in which a flue-pipe (*ṣaffāra*) or reed-pipe (*zāmīr*) is winded in the same way.⁵ These works have only survived in Arabic, and it is highly probable that it was such treatises as these that led to Archimedes being credited with the "invention" of the *organum hydraulicum*, which is not necessarily the *hydraulis*.

Apollonios of Perga (fl. 247-205 B.C.), called by the Arabs Abliniyūs, Ablūniyūs, Būlunyās, and Balinūs,⁶ is credited with the authorship of a work on an automatic wind instrumentalist entitled *Ṣan'at al-zāmīr* ("Construction of the Wind Instrumentalist"), which has only come down to us in an Arabic version. It may have been translated by one of the Banū Mūsā (Muḥammad, d. 873), Hilāl ibn Abī Hilāl (d. c. 883), or Thābit ibn Qurra (d. 901), who translated his *Conic Sections*. The instrument described is an *hydraulic air compressor*. Water pours into a cistern hitherto filled with air. The rising water compresses the air in a wind chest, which makes a sounding pipe (*nāy*) speak.⁷

In the third century B.C., an improvement was made in

⁵ British Museum MS., Or. Add. 23391, folio 20 v. For a description of another exemplar of the MS. see Carra de Vaux as quoted above, and Wiedemann's *Byzantinische u. arabische akustische Instrumente*, 145, and his *Uhr des Archimedes*, 193, 194.

⁶ The first is the form in the British Museum MS. quoted above.

⁷ It is described by Carra de Vaux, *op. cit.* above, 307, and Wiedemann, *op. cit.*, 149.

The Invention of the Organ.

stabilising the wind pressure of the ordinary bellows or piston-blown organ. Instead of the pressure stability being maintained by horizontal bellows as in the *third stage* mentioned by Dr. Maclean, water was used for this purpose, hence the term *hydraulis* being given to the apparatus. Its inventor is generally supposed to be Ktēsibios (fl. 246-221 B.C.). The claim rests mainly on the testimony of Athēnaïos. Paul Tannery has carefully sifted the evidence, and he has demonstrated that Ktēsibios must have lived under Euergetes I (246-221 B.C.), and not under Ptolemy Euergetes II (146-116 B.C.) as Athēnaïos thought.⁸

Chappell says that not only Athēnaïos, "but also Vitruvius before, and Pliny after his time, unite in ascribing it to Ktēsibios, as do all earlier writers."⁹ Chappell also alludes to the epigram of Hedylos in which, he says, there is mention of the "*hydraulic organ* (= *hydraulis*), and to Ktēsibios as its inventor." The Pliny evidence is scarcely valid, since the writer refers to hydraulic machines in general.¹⁰ The "earlier writers" mentioned by Chappell are Hedylos and Philōn, but this evidence is valueless. Hedylos simply tells us that Ktēsibios constructed a *rhyton* in a temple dedicated to Arsinoe Zephyritis.¹¹ This *rhyton* was not an *hydraulis*, but a cup which emitted a musical sound, probably worked on the principle of the Archimedes *organon hydraulikon*, which was a *hydraulic air compressor*, or one of the whistling instruments mentioned and described by Philōn and Herōn.¹² Chappell

⁸ Athēnaïos, iv, 75. Tannery, *Athénée*, 23-7.

⁹ Chappell, 365.

¹⁰ Pliny, *Hist. Nat.*, vii, 38. "*Pneumatica ratione et hydraulicis organis repertis.*"

¹¹ Athēnaïos, xi, 97.

¹² Cf. Daremberg et Saglio, iv, 865; and Tannery, *Athénée*, 24.

The Organ of the Ancients.

also says that Philōn refers "to several inventions by Ktēsibios, and, among them, to the *hydraulic organ* (= *hydraulis*)."¹³ This is also incorrect. Philōn does not mention Ktēsibios as the "inventor" of the *hydraulis*. He only refers to him in respect to what he taught concerning the "nature of air," and the remark is made after a reference to something that Philōn himself had written on the *hydraulis*, yet Ktēsibios is not actually mentioned as the inventor, although he probably was.¹⁴

The first glimpse that we get of the *hydraulis* is given by Philōn, when he speaks of "the syrinx played with the hand called the *hydraulis*."¹⁵ Philōn himself wrote on the *hydraulis*, but the work has been lost, unless we are to allow, with Baron Carra de Vaux, that the Arabic Mūristus treatise is Philōn's.¹⁶ This Mūristus, Mīristus or Mūrṭus, has however, a claim for an independent existence as the inventor of the *hydraulis*, and as the author of a treatise on its construction, as well as one on the *pneumatic organ*.

From the ninth to the fourteenth century A.D., this Mūristus finds a place in Arabic works. Al-Jāhīz (d. 868) speaks of earlier and later Greek theorists in the domain of music thus: "From Pythagoras to Euklid and Mīristus," and then of earlier and later mechanicians thus: "From Archimedes to Mūristus."¹⁷ We know from Ibn al-Nadīm (d. c. 996), Ibn al-Qiftī (d. 1248), and Abū'l-Fidā' (d. 1331), that a Mūrṭus or Mūristus was the author of treatises on organ construction. Copies of these works have been preserved and may be found in

¹³ Chappell, 328.

¹⁴ Philōn, 77.

¹⁵ Philōn, 77.

¹⁶ Carra de Vaux, *Philon de Byzance*, 38; *L'Invention de l'hydraulis*, 340.

¹⁷ Al-Jāhīz, 133, 143.

The Invention of the Organ.

the British Museum, the library of St. Sophia at Constantinople, and at the Three Moons College of the Greek Orthodox Church at Bairūt.

The identity of this Mūristus has already been discussed by Baron Carra de Vaux and the present writer.¹⁸ The former has pointed out that in the Arabic version of Philōn's *Pneumatics* (*Kitāb fī'l-ḥiyal al-rūḥāniyya*), the dedicatee is a certain Riṣṭūn or Aristūn. In the Latin translation derived from the Arabic, the dedicatee is called Marzotom, whilst the same author's *Belopoiika*, and the *Treatise on the Klepsydra* attributed to Archimedes, also refer to this same person.¹⁹ These facts have led Baron Carra de Vaux to suggest that the Mūristus of the organ treatises is the same person as the Riṣṭūn, Aristūn, etc., mentioned above, and that all these names are simply malformations of Ariston or Aristos, the friend to whom Philōn dedicated his works.

The learned French savant has also very plausibly argued how Mūristus came to be credited with the authorship of the organ treatises. The scribes, he says, misread the Arabic particle *li* as the genitive instead of the dative, so that instead of "by Mūristus" we ought to read "to Mūristus." Of course, if we accept the Ariston (Mūristus) dedication theory, we must accept the Philōn authorship of the organ treatises, together with the Archimedes *klepsydra* treatise, and Baron Carra de Vaux is practically prepared to urge this.²⁰

Yet it is almost impossible to accept the Philōn authorship of both the organ treatises. The one on the *pneu-*

¹⁸ *Studies in Oriental Musical Instruments*, 30.

¹⁹ Carra de Vaux, *Philon de Byzance*, 29, 38. *L'Invention de l'hydraulis*, 338.

²⁰ Cf. his *Notes d'histoire des sciences*, 449.

The Organ of the Ancients.

matic organ describes an instrument far too primitive to have been composed by him, whilst even the treatise on the *hydraulis* appears to belong to a period anterior to the Philōn of the *Pneumatics*. On the other hand, the latter, *as it stands*, cannot be the work of an ancient Greek, because the author or compiler relates that he constructed an organ of the type which he describes, for a "King of the Inner Franks," and he also uses the phrase: "If Allāh Wills." These passages however, may be additions by a copyist, compiler or translator, just as the prefatory Islāmic invocation—*Bismillāhi* ("In the Name of Allāh") is.

A likely elucidation of the enigma of the name Mūristus was suggested to me by Professor D. S. Margoliouth, of Oxford, who pointed out that the name Mūristus or Miristus was evidently intended for Ameristos (Ἀμερίστος) the ancient Greek mathematician.

We only know of Ameristos through Proklos on Euklid (i, 65, 11-15) where we read: "Next to Thales, Ameristos, a brother of Stēsichoros, is mentioned as having engaged in the study of geometry; and from what Hippias of Elis says it appears that he acquired a reputation for geometry."¹ But even his name is uncertain. Suidas (*sub* "Stēsichoros") has Mamertinos. In Freidlein's edition of Proklos it is written Mamerkus, whilst in Heiberg's edition of Herōn's *Definitions* we have Mamertios or Marmetios. As Stēsichoros lived about 630-550 B.C., one might conceivably allow him the authorship of the Mūristus treatise on the *pneumatic organ*, but hardly the one on the *hydraulis*, which must be a far later work. In all probability it was the fame of Ameristos that had come down to the Arabs via Proklos (Bruqlus), which led a scribe to write

¹ Heath's translation.

The Invention of the Organ.

Mūristus, when he saw a name in his manuscript which looked like it!

It is certainly strange, as Baron Carra de Vaux observes, that Ktēsibios should be unknown in Arabic, and yet be of such importance in Greek and Latin literature. Is it not possible, as I pointed out in 1926,² that the name Mūristus is simply a scribal slip which ultimately can be traced back to the form Ktēsibios, or, as it would be written in Arabic—Qatāsibiyūs? What strengthens this opinion is the name of the inventor of the *hydraulis* given in the *Kitāb al-siyāsa* attributed to Aristotle. This work was translated into Arabic from the Greek by Yūḥannā ibn al-Baṭriq (d. 815) and the inventor of the *hydraulis* is here called Yāyastayūs, Thāstiyūs, Thāsītūs or Tāsītūs, in the various copies of this treatise.³

Indeed, when one sees these various names in Arabic, and then conjectures the gradual transformation of the name from Ktēsibios to Mūristus, at the hands of the copyists, in the following way, the opinion put forward by the present writer is not altogether unfeasible.

قتاسيبیوس = Qatāsibiyūs.

یایستایوس = Yāyastayūs.

ثاستیوس = Thāstiyūs.

ثاسیطوس = Thāsītūs.

تاسیطوس = Tāsītūs.

میرسطوس = Miristūs.

مورسطوس = Mūristūs.

² *Journal, Royal Asiatic Society*, 1926, page 503.

³ See my *Studies in Oriental Musical Instruments*, page 30.

The Organ of the Ancients.

It will be recognised that the passage from "Mūristūs" (with a long "ū") to "Mūristus" (with a short "u") is simple enough, and is quite a common substitution in foreign names.

Of course it may be argued that we know little of the writings of Ktēsibios, since nothing has survived of them. That, however, ought not to prevent us from accepting the Arabic Mūristus treatise on the *hydraulis* as the work of Ktēsibios,^{3a} as there are several Greek works that have only survived in Arabic, including the *Pneumatics* of Philōn, the *Mechanics* of Herōn, the *Conic Sections* (Books V to VII) of Apollonios, and the treatises on the *Automatic Wind Instrumentalist* by Archimedēs and Apollonios.

Finally, there is the possibility that Mūristus may even have a separate existence from either Ameristos, Ariston or Ktēsibios, since we have several writers mentioned in Arabic works that appear to be quite unknown in Greek or Latin literature, such as the astronomer Paulisa in Al-Bīrūnī,⁴ the musical writer, Fandurūs of Ibn Khurdādhbih,⁵ Qanṭwān of the *Fihrist*,⁶ and Sā'āṭus of the Mūristus treatises.⁷

^{3a} Needless to say, Ktēsibios could scarcely have written the Mūristus treatise on the rather primitive pneumatic organ.

⁴ Al-Bīrūnī, *India* (Sachau Edition), i, 153.

⁵ Farmer, *Studies in Oriental Musical Instruments*, 60. Also called Qandurūs. See Dr. K. Merkle's *Die Sittensprüche der Philosophen* (1921), page 55.

⁶ Or Qitwār.

⁷ See *post* p. 61.

CHAPTER III.

THE ORGAN FROM HEBREW SOURCES.

"Adeoque, quæ de immani sonno Magrephæ narrant, vel fabulosa esse, vel saltem cum grano salis accipienda."—Joh. D'Outrein, *De instrumento magrepha*.

THE pneumatic organ, as already shown, belongs to a period long anterior to the fourth century B.C., and hydraulic organs can definitely be traced to this date, whilst the *hydraulis* was certainly known in the third century B.C. Whether the pneumatic organ came from the Greeks, as did the hydraulic organ and the *hydraulis*, or from Egypt or Babylonia-Assyria, which were the culture-determining forces of pre-Hellenic antiquity, we know not. The probability is that it was known in the Mesopotamian plains before Greece had it. Yet the fact remains that the Assyrian language has not handed down any word that gives a determinate clue that the organ was known in these parts.

The earliest trace of the organ in the literature of the Semitic east comes from Hebrew-Aramaic sources of a much later date. Strangely enough, however, this fount has been neglected by historians of the organ, and with the exception of the savants utilised by Ugolinus in his *Thesaurus antiquitatum sacrarum* (1744-69), no deep interest has been evinced in this material.

The Organ of the Ancients.

§ 1.

The oldest Hebrew literature that we have, the Old Testament, does not mention an instrument that we can recognise with any degree of certainty as a "mechanically wind-fed instrument" like our organ. Yet there are writers who are prepared to conclude that the *mashroqitha* of *Daniel*, iii, 5, 7, 10, 15, was an early type of pneumatic organ. The cue for this was given by Athanasius Kircher, the learned, though imaginative author of the highly interesting *Musurgia Universalis* (1650).

Kircher's description of the *mashroqitha* has been quoted by almost every historian of the organ, and his delineation of the instrument has been reproduced *ad nauseam*, for the most part erroneously. In view of this, it may be worth while to consider Kircher at first hand.¹ The *mashroqitha*, according to Kircher, comprised a wooden chest, in the top of which were fitted eight pipes of various lengths and diameter. By the manipulation of *sliders* moved by the fingers, these pipes were made to speak by means of wind supplied by a skin bag within the chest, which was inflated by the mouth, through a pipe which passed along, and entered, the back of the chest.

¹ "Masrakitha (= mashroqitha), a sibilo quem faciebat, sic dictum instrumentum erat πολυκάλαμον sive multorum calamorum, qui simul ligati & in ligno quodam in formam. Thecæ adaptato gradatim infixi disponebantur, calami vero aperti supra, infra pellis obductione certo quodam ligno obturabantur, eratque instructum manubrio quodam, a quo dilatata cista paulatim in augustum spatium coarctabatur: Instrumentum applicabatur labiis & insufflatione facta digitorum foramina e latere nunc claudentium nunc aperientium ope varius percipiebatur sonus pro ratione longitudinis, aut latitudinis brevitatisque fistularum, vel etiam pro insufflationis intentione. Unde colligo hoc instrumentum idem prorsus fuisse cum Syringe sive heptaULO Panos; ut paulo post patebit." Kircher, *Musurgia Universalis*, i, 53.

The Organ from Hebrew Sources.

Of Kircher's delineation of the *mashroqitha*, Carl Engel said that it was not improbable that some instrument of this kind was known to the Hebrews and to the Assyrians, but Kircher's design, he added, was probably "a product of the imagination."² Kathleen Schlesinger also warns us that the delineation must be accepted "with a certain amount of reserve."³ With these opinions, most people who have studied the question at first hand, will entirely agree, and the only reason for troubling about Kircher at present is due to the fact that he actually hit upon an earlier type of organ inflation, *by the mouth*. Whether Kircher had documentary evidence for this, or whether he was following a natural deduction, we have no knowledge. That such a type actually existed was not definitely acknowledged until recent years,⁴ and it is now confirmed by Arabic documents. Further, it is high time that attention was drawn to the so-called Kircher design used by organ historians, which is an absolute travesty of the original.⁵

The next important stage in organ development was the introduction of bellows, either manual or pedal. We have evidence of an instrument of this sort dating from prior to 200 B.C. in one of the terra cotta objects unearthed by

² Engel, 286.

³ Schlesinger, *Researches*, 185. This author says that Kircher calls it "the *mashroqitha* or *magraketha* of the Chaldees." The word he uses is *masrakitha*, with no mention of the "Chaldees."

⁴ Schlesinger, *The Organ*, 226. Matthews, *A Handbook of the Organ*.

⁵ Hawkins, *History of Music*, i, plate v, reproduces Kircher's design with only seven pipes instead of eight, and with *sliders* that do not comport with them. These errors have been copied by most of the English writers on the organ, who pretend to take their design *direct from Kircher*. See Hopkins and Rimbault, *The Organ*, 3. Grove's *Dict. Mus.*, iii, 736. Stainer, *Music of the Bible*, 121. Schlesinger, *Researches*, 185. Audsley, *Art of Organ Building*, i, 7.

The Organ of the Ancients.

W. Burckhardt Barker at Tarsus in Cilicia. "The instrument," says this writer,⁶ "consists of a vertical row of pipes, the length unknown, as the lower portion is wanting; they are inserted into a small air-chest, which appears inflated in the middle part." Commenting on this instrument, Kathleen Schlesinger says that although both drawing and description are somewhat vague, "there is no reason for doubt that this was an organ."⁷ Confirmation comes, although the date is later perhaps, from another terra cotta object preserved in the Louvre. This latter was also discovered at Tarsus, and it shows the rear of an organ with fifteen pipes.⁸ That the organ was known even further East, may possibly be demonstrated from the curious figure discovered on the site of ancient Khotan in Chinese Turkestan by Sir Aurel Stein.⁹

We now come to Jewish sources. Did the Jews possess the organ in common with their neighbours in Asia Minor? Whatever notion the Semitic East had of the organ prior to the Hellenistic period, the new culture forces, dating from the time of Alexander the Great, became most marked from the end of the third century B.C., not merely in political life, as we see in the books of *Maccabees*, but in art and literature,¹⁰ as we know from *Daniel*, iii (c. 164 B.C.). Post-biblical literature, as exemplified in the *Targumim*, *Midrashim* and *Talmud*, reveal a weighty impress of later Greek influence.

Since we can match almost every musical instrument of Greece and Rome with one in Syria and Palestine, there

⁶ Barker, *Lares and Penates*, 260-1.

⁷ Schlesinger, *The Organ*, 266.

⁸ Froehner, *Les musées de France*, pl. xxxii.

⁹ Stein, *Ancient Khotan*, pl. xliii.

¹⁰ *Harvard Theological Review*, xvii, 334-5.

The Organ from Hebrew Sources.

is no reason why the pneumatic organ, which must have been known in the former countries, should not have found acceptance in the latter. Yet it has to be acknowledged that there is no mention of the instrument in the Apocrypha (c. second-first century, B.C.), nor in Philo Judæus (b. ca. 20-10 B.C.), nor in Josephus (b. 37 A.D.). Indeed, it is not until we come to the *Talmud* that we get anything like evidence for its existence among the Jews, and even this has been challenged. In the *Talmud* there is mentioned an instrument of the Temple called the *magrephah*, which is claimed to be a pneumatic organ in the second stage of development,¹¹ that is to say, with manual or pedal bellows.

The evidence of the *Talmud* has long been suspect. This has been due, mainly, to the conflicting descriptions of, and references to, this *magrephah* by the rabbis. But we must remember that after the fall of Jerusalem in 70 A.D., music generally was *anathema* amongst the Jews.¹² Its prohibition was a sign of mourning for the destruction of the Temple, and the interdict has had its influence on Judaism up to comparatively modern times.¹³ As a result, it is quite possible that the rabbihood in the Talmudic period was not sufficiently conversant with instruments of music to give precise particulars of such a contrivance as the *magrephah*.

Before we can deal with the evidence of the *Talmud*, it seems advisable, for the sake of those readers who may not be acquainted with this literature, to scrutinise the historical aspect of this work, which has been termed "in many respects unique among the literary monuments of the world."¹⁴

¹¹ Schlesinger, *The Organ*, 266.

¹³ Abrahams, *Jewish Life*, 253.

¹² *Jew. Ency.*, ix, 432.

¹⁴ Oesterley and Box, 86.

The Organ of the Ancients.

There are two great collections of the Oral Law with the Jews—the *Palestinian Talmud* and the *Babylonian Talmud*, both of which may be said to have been finally redacted before the year 500 A.D. The *Talmud* is made up of the *Mishnah*, in Hebrew, “in the form that was officially sanctioned by Rabbi Yhudah I, about 190 or 200 A.D.”¹⁵ and secondary material called *Gmara*, for the most part in Aramaic, containing traditions of lesser authority. All this material is interpreted and discussed by the *Amoraim* or “Speakers” (ca. 220-500), some of whom hand down traditions from the *Tannaim* or “Teachers” (ca. 10-220), which reach back to the time of the destruction of the Temple.¹⁶

Among the *Amoraim* who will be quoted on the question of the *magrephah* of the Temple are, Rab, Shmuel, Rab Nahman bar Yiqhaq, Rab Mattnah, and Rabbah Shela. Rab, or more properly, Abba Arika (d. ca. 247), was the chief Babylonian *Amora*, and the founder of the Sura Academy. It was Rab who “determined the form and method of the *Babylonian Talmud*,”¹⁷ taking the *Mishnah* of his master, Rabbi Yhudah I, as his basis. Shmuel, or Mar Shmuel (d. ca. 254), a contemporary teacher, was Principal of the Nharde’a Academy. The disputes between Rab and Shmuel “constitute the main body of the *Babylonian Talmud*.”¹⁸ Rab Nahman bar Yiqhaq (d. 320) was a pupil of Shmuel and he also became Principal of the Nharde’a Academy. Rab Mattnah, or Rabbah ben Mattnah, was a Babylonian *Amora* of the fourth century, as was Rabbah Shela, the latter being a pupil, probably, of Rab Nahman bar Yiqhaq, whose say-

¹⁵ Oesterley and Box, 82.

¹⁶ Rodkinson, x (2), 2.

¹⁷ Oesterley and Box, 119.

¹⁸ *Ibid.*

The Organ from Hebrew Sources.

ings he transmits. This disposes of the historical aspect of the *Talmud*, and we can now consider what this work tells us about the instrument called the *magrephah*.

The instrument called the *magrephah*, identified by some writers as a pneumatic organ, has been the subject of a two thousand years' controversy. The instrument is not mentioned in the *Mishnah*, but only in the *Gmara*. At the same time, the *Palestinian Talmud*, tractate *Sukkah*, v. 4, says:

“The Levites accompanied themselves with lyres (*kin-nor*), harps (*nebel*), cymbals (*mçiltaim*), trumpets (*haçofereth*), and numerous other musical instruments.”

It is quite possible, therefore, that the *magrephah* may have been counted among the “other musical instruments,” or, if not, it may have been that it was not one of the instruments of praise like the above, but was used for other purposes, as we shall see presently. At any rate, the *magrephah* is described in both the *Palestinian Talmud* and *Babylonian Talmud*, although not in a sufficiently precise way to enable us to be certain of its category.

The tractate *Sukkah*, v. 6, in the *Palestinian Talmud*, describes the *magrephah* thus:

“The *magrephah* [is described by] Rab and Shmuel. One says that it had ten holes, and each emitted one hundred different sounds (*semar*). The other says that it had one hundred holes, and each emitted ten different sounds. Altogether it gave one thousand sounds.”

The tractate *Arakin*, ii, 6, in the *Babylonian Talmud*, gives us a little better description of the instrument:

“Rabbah bar Shela said, in the name of Rab Mattnah, in the name of Shmuel, that there was a *magrephah* in the Temple. It had ten holes, and every hole emitted ten different sounds, so that altogether it emitted one hun-

The Organ of the Ancients.

dred different sounds. In a *mishnah* we have learned that it was 54 cm. (= one *ammah*) broad, and 54 cm. high. And there was a handle projecting from it on the right side. And it had ten holes, each of which emitted one hundred different sounds, so that altogether it emitted one thousand different sounds. And Rab Naḥ-man bar Yīḥaq said, 'Take note, the *mishnah* exaggerates.'

The *mishnah* which "exaggerates" is evidently the one quoted from the *Palestinian Talmud*, as above, and it may be remarked that the latter is admittedly less authoritative than the *Babylonian Talmud*,¹⁹ since "it was apparently not subjected to a final revision, and has reached us in an incomplete form."²⁰ This may partly account for the so-called "exaggeration." On the other hand, we have already pointed out that the Byzantines seemed to have nicknamed the organ, "the instrument of a thousand voices," a phrase which may have been borrowed by the Jews, as it was by the Arabs and Persians, and may have contributed to the "exaggeration" concerning the "thousand different sounds."¹

The tractate *Tamid*, iii, 8, in the *Babylonian Talmud*, also tells us that there was a *magrephah* in the Temple, and that it had a very powerful sound. The passage runs:

"From Jericho they heard the sound of the Great Gate [of the Temple] that was opened. From Jericho they heard the sound of the *magrephah*. From Jericho they heard the sound of the appurtenance made by the Ben Qattin for the laver. From Jericho they heard the voice

¹⁹ Rodkinson, x (1), 18-9. (2), 48. ²⁰ Oesterley and Box, 127.

¹ Farmer, *Byzantine Musical Instruments*, 5, 6.

The Organ from Hebrew Sources.

of the chief Temple crier. From Jericho they heard the sound of the flute (*ḥalil*). From Jericho they heard the sound of the bell (*ṣelṣal*). From Jericho they heard the sound of the song (*shir*). From Jericho they heard the sound of the horn (*shophar*). From Jericho they heard the voice of the High Priest."²

A similar passage occurs in tractate *Sukkah*, v. 3, in the *Palestinian Talmud*.

The most perplexing passage on this question is the one in *Tamid*, v. 6, in the *Babylonian Talmud*, and it is this relation that has caused most of the differences of opinion among the commentators on the identity of the *magrephah*. The passage reads:

"One of them [who served in the Temple] took the *magrephah* and 'sounded' (*zaraq*) it between the porch and the altar. No one could hear the voice of his neighbour in Jerusalem because of the sound of the *magrephah*. It was used for three purposes: (1) The priest who heard its sound knew that his brother priests had entered to worship, and he ran and came: (2) The Levite who heard its sound knew that his brother Levites had entered to sing, and he ran and came: (3) The chief of the stationary men (*Ma'amadh*) placed those that had been unclean at the Nikanor Gate."

These four extracts comprise all that the *Talmud* has to tell us about the instrument called the *magrephah*, and we may proceed to enquire what type of instrument it was.

Some say that the *magrephah* was a pneumatic organ, whilst others urge that it was a pulsatile instrument. Commentators hold that both these types were in use, and

² The Latin translation of these passages in the *Thesaurus antiquitatum sacrarum* of Ugolinus (xviii, 486), has got slightly mixed. The *magrephah* passage is out of its place, and the *ṣelṣal* passage is entirely omitted.

The Organ of the Ancients.

that both were called by this name *magrephah*. This has led modern writers from the time of Abraham de Porta Leone (d. 1612) to speak of these instruments respectively as the *magrephah* of 'Arakin and the *magrephah* of Tamid.³

The *magrephah* of 'Arakin (ii, 6) is certainly an instrument which could be likened to some composite wood-wind instrument. All that we are told, however, by the *Amoraim*, is its dimensions, form, and that "it had ten holes, and every hole emitted ten different sounds."⁴ The famous commentator, Rashi (d. 1105) sought to explain the passage as follows:

"Each hole had a pipe (*qaneh*) which had ten holes in it, and every hole emitted one sound, so that altogether it [the *magrephah*] emitted one hundred sounds."

It will have been noticed that there is no mention of the method of inflation of this supposed pneumatic organ or composite wood-wind instrument. One of the later Jewish writers, Abraham de Porta Leone, suggested bellows or bags. This author describes the *magrephah* at length, drawing freely on his imagination, although making it consistent with the descriptions of the *Amoraim* and commentators. In consequence of this, his description deserves a place here. Abraham de Porta Leone was an Italian Jew whose *Shilte ha-gibborim* was published in

³ Abraham de Porta Leone, 37, 41.

⁴ Miss Schlesinger (*The Organ*, 266) points to this "description in the *Talmud*" of the *magrephah* "with bellows." "The quotation," she says, "as given by Blasius Ugolinus, states that the instrument known as the *magrephah* of 'Arakin (Treatise xxxiii of *Bab. Talmud*, see *Thesaurus Antiquitatum Sacrarum*, xxxii, 11 and 21), consisted, as the *Shilte ha-gibborim* teaches, of several rows of pipes, and was blown by bellows." The "quotation" is not from the *Talmud* but from Kircher. Further, 'Arakin is Treatise xxxii, not xxxiii. See "Note" on p. 44.

The Organ from Hebrew Sources.

Hebrew at Mantua in 1612, the same year as the author's death. Here is his description of the *magrephah* of 'Arakin.⁵

"The *magrephah* was like a box of wood . . . disposed in the likeness of the shovel of the bakers, closed in, above and below, and on all its sides, and completely hollow within. Its length was about 135 cm. (= $2\frac{1}{2}$ *ammah*), and [in shape] bent. Its width about 54 cm. (= 1 *ammah*), and its height the same. Within it were enclosed ten reed-pipes, with ten holes in them, some of the reed-pipes being long and thick, and others short and thin. They were fixed horizontally and not vertically, and the holes of the reed-pipes, which were in an even row, were turned and arranged so as to face the bottom part of the box and not the top part. And in the two sides of the box, i.e., the North and South of it, were bellows. And in the East of the box were the heads of the ten reed-pipes, joined to it, at a distance from the bottom of the box by about 27 cm. (= $\frac{1}{2}$ *ammah*). And in the West side of the box there protruded the ends of the ten reed-pipes, open and empty, a short distance from the ten holes in them, so that the sounds of the reed-pipes could be heard distinctly, and not die inside the instrument. . . . And in this instrument were placed one hundred bags, ten for each reed-pipe, one for every hole. And in the end of the bags towards the inside, were upright irons, with a little lid on the head [of each] in such a way that they could manage to close on (*lit.* 'strike') and stop up, with those little lids, the holes of all the reed-pipes, by tapping the keys which were on the side [of the instrument], until, by the closing of the lids upon the holes, and the driving of the

⁵ Abraham de Porta Leone, 47, *et seq.*, Hebrew text with Latin translation in Ugolinus, xxxii.

The Organ of the Ancients.

wind into the reed-pipes with force, there were produced in them the sounds, varied and pleasant, like those which are produced in the flutes (*halil*) by the closing of a man's fingers upon them, when they blow into them. So the *magrephah* emitted, quite conveniently, all the hundred sounds of which our rabbis speak, distinct from one another, due to thickness and fineness and length and shortness of the reed pipes, and the distance of the holes in them from the first hole to the tenth. And he who played upon this instrument was one man and no more. Thus I imagine the form of the *magrephah* and its function. If you are satisfied, then so am I. If not, then choose another opinion which may be more correct."

Kircher, in his *Musurgia Universalis* (1650), although he set great store by Abraham de Porta Leone, differed from the latter in his conception of the *magrephah*. According to Kircher, the *magrephah* was "similar to our church organs," and although he quotes from the *Shilte ha-gibborim* as one of his authorities, he depicts the instrument as an oblong box in which are fixed, *vertically*, *thirteen* pipes, which appear to answer to "sliders" placed in front of the box, whilst at the back are two bellows.⁶ The pipes of Kircher are not furnished with "mouths" as to-day. Printz, in his *Historische Beschreibung der edelen Sing und Kling-kunst* (1690) sought to remedy this by adding "mouths," quoting a certain Johannes Schütterus as his authority for the deviation.⁷ In this design Ugolinus follows Kircher,⁸ but Hawkins subscribes to Printz.⁹ Later

⁶ Kircher, i, 54.

⁷ Note the title of this book of Schütterus as quoted by Printz and Hawkins.

⁸ Ugolinus, xxxii, 371.

⁹ Hawkins, i, 256-7, pl. v.

The Organ from Hebrew Sources.

copyists, mostly professing to reproduce Kircher, really borrow from Hawkins.¹⁰

Kircher's design, in spite of the fact that it has become almost a "hardy annual" with historians of music, is not even consistent with the description in the *Talmud*, let alone the *Shilte ha-gibborim*, which he put such trust in. Whatever reservation we may allow in regard to Abraham de Porta Leone, we can afford to dismiss the *magrephah* of Kircher once and for all.

It must be acknowledged that the *naïveté* of Abraham de Porta Leone in the *coda* of his description, disarms all criticism. He admits that he has no authority for positing the bellows or even the organ case, although he argues with congruity that the holes in the reed pipes could scarcely have been manipulated by the digits of the hands. Yet it is remarkable that he should have failed to notice the "handle" which is so distinctly mentioned in the *Talmud* as projecting from the side of the instrument. This would have given grounds of justification for his introducing a mode of inflation, since this "handle" might very well have been the lever which worked circular bellows or pistons, a principle often depicted in the mechanism of organs in mediæval MSS.¹¹

Abraham de Porta Leone considered that the organ case was curved "in the form of the bow of the arrows," concave in front and convex at the back. When the "handle" was added to the side of this, one can appreciate why the instrument was called a *magrephah*, because it would resemble "a shovel," as the commentators tell us.¹² Although

¹⁰ See Stainer, *Music of the Bible*, 122. Grove's *Dict. Mus.*, iii, 736. Schlesinger, *Researches*, 200.

¹¹ Ruelle, 316. Buhle, tab. 14. Grove's *Dict. Mus.*, iii, 736.

¹² Maimonides and Abraham de Porta Leone.

The Organ of the Ancients.

this appears to be a reasonable explanation for the word being used, there may be a more likely origin. The root of *magrephah* is *garaph*, a word which means: (1) "to carry, snatch away, sweep away," and (2) "to grasp." Hence *magrephah* means "a ladle, shovel, etc.," whilst *eghroph* means "a fist." This secondary meaning prompts the suggestion that the name *magrephah* for a pneumatic organ or composite wood wind instrument, was given because it "comprised, embodied, embraced or enclosed" within itself, a number of different sounds.¹³ The Arabs had a similar mode of expression in *jama'a*, which means "to collect, include," hence *jum'*—"a fist." They called the pneumatic organ the *urghanun al-jāmi'* or "comprehensive organ."¹⁴ So far the *magrephah* of 'Arakin, ii, 6, which has been considered to be a pneumatic organ.¹⁵

The *magrephah* of *Tamid* (iii, 8; v, 6) has been generally understood by later commentators to refer to a different instrument from the *magrephah* of 'Arakin (ii, 6). Rashi (d. 1105), however, only recognises one species of musical instrument called *magrephah*, since he says: "There are two sorts of *magrephoth*, one for the ashes [the shovel], and one for music."¹⁶ Maimonides (d. 1204) commenting on *Tamid*, iii, 8, refers us to 'Arakin, ii, 6, which shows that he considered the *magrephah* in the former to be identical with that in the latter.¹⁷ The instrument in *Tamid*, iii, 8, is said to have possessed so

¹³ An instrument of music called the *jarūfa* (a word that comes from the same root as *magrephah*) was known to the Arabs, and I am indebted to Professor D. S. Margoliouth for calling my attention to the mention of it in the *Talbīs iblīs* (Cairo, 1340 A.H.) by Abū'l-Faraj ibn al-Jauzī (d. 1200).

¹⁴ *Mashriq*, ix, 23.

¹⁵ *Jew. Ency.*, ix, 432.

¹⁶ Marginal commentary, *Talmud Babli*. Bartolocci, 474.

¹⁷ *Ibid.* D'Outrein, 1121.

The Organ from Hebrew Sources.

powerful a tone as to be heard at Jericho, which was nine or ten miles distant.¹⁸ The learned Lightfoot says that we cannot plead the literal truth of this statement, "seeing it is apparent that it is uttered by way of hyperbole: only it may not be improper to observe, how common the phrase was: 'From Jerusalem to Jericho,' which is also used in *Luke*, x, 30."¹⁹ On the other hand, we have an account of the Mūristus *hydraulis*, the sound of which could be heard sixty miles.²⁰ Further, the reputed "Letter to Dardanus" of St. Jerome (d. 430) tells of an organ at Jerusalem which could be heard at the Mount of Olives, quite a mile distant.¹ At any rate, there are no particularly valid reasons for regarding the instrument in *Tamid*, iii, 8, as being different from that of 'Arakin, ii, 6.²

It is, however, the *magrephah* mentioned in *Tamid*, v, 6, that has been regarded as so radically different from that mentioned elsewhere. A gloss on this passage says that this *magrephah* was a great vessel which was rung so as to make a sound, whilst another opinion is that it merely refers to the shovel of the altar which, being large, and of brass, made a loud sound when it was either rung or thrown on the floor of the Temple.³ We find therefore in the *Tosaphoth Yom Ṭob* that three distinct objects carried the name *magrephah*—the altar shovel and two musical instruments.⁴ Another commentator, Obadya de Bertinoro (d. 1510) is inclined to a similar view.

¹⁸ Cf. Josephus, *Bell. Jud.*, iv, 3. Strauss, F., *Helon's Pilgrimage to Jerusalem*, ii, 125.

¹⁹ Lightfoot, *Prospect of the Temple*, chap. xxxvi.

²⁰ *Mashriq*, ix, 21. *Ikhwan al-Ṣafā'*, i, 22.

¹ Migne, *Patr. Lat.*, xxx, 219.

² Cf. Jastrow, s.v.

³ Lightfoot, *Temple Service*, vii, 3, and ix, 5. *Prospect of the Temple*, xxxvi. Braunius, 868.

⁴ Quoted by Braunius and D'Outrein.

The Organ of the Ancients.

What led the commentators and other writers to discriminate between the *magrephah* in *Tamid*, v, 6, and the instrument mentioned elsewhere, was the use of the word *zaraq* which has been translated on page 29 as "sounded." Most of the old Latin translators made *zaraq* equate with *projicio*, because the literal meaning of *zaraq* was "to sprinkle, cast, throw, scatter."⁵ In the face of this it was difficult to link up this word with the instrument mentioned in 'Arakin, ii, 6, and therefore another instrument or appurtenance had to be imagined. Abraham de Porta Leone supposed a pulsatile instrument, although he confessed that he could not describe it.⁶ Later writers, such as Kircher,⁷ and Lightfoot,⁸ fancied that it was a bell, an opinion which Hawkins gave acquiescence to.⁹ Pfeiffer conceived a kettledrum,¹⁰ whilst Saalschütz favoured the altar shovel.¹¹ The latest opinion, that of the lexicographer, Marcus Jastrow, is that it was "a sort of *tympanum*."¹²

There is still the possibility however, that the *magrephah* of *Tamid* (v, 6) was the same instrument as the *magrephah* of 'Arakin (ii, 6). Why should *zaraq* not be used in a figurative sense in the same way as we speak of "throwing the voice"? *Zaraq* has a figurative meaning elsewhere,¹³ although not with the latter meaning. In Latin, there is a metaphorical use of the word *projicio*, where it means "to expel, drive out, obtrude, utter."

Still, whatever type of instrument the *magrephah* of *Tamid* (v, 6), was, we can perhaps accept the *magrephah*

⁵ Braunius, cap. ix. Ugolinus, xxxii, 38.

⁶ Abraham de Porta Leone, 37. ⁷ Kircher, i, 52.

⁸ Lightfoot, *Temple Service*, ix, 5. ⁹ Hawkins, i, 256-7.

¹⁰ Pfeiffer, 52.

¹¹ Saalschütz, 131.

¹² Jastrow, s.v.

¹³ *I Hosea*, vii, 9.

The Organ from Hebrew Sources.

of 'Arakin (ii, 6) as a pneumatic organ or composite wood wind instrument, as most writers have done since the time of Abraham de Porta Leone, although the latest Talmudic lexicographer, Marcus Jastrow, prefers a non-committal definition of the instrument as "a musical instrument of the Temple."¹⁴

It has been mentioned that the pneumatic organ was known to Greece and Rome, and in view of the close musical connection between all the countries of the ancient world,¹⁵ there is no reason why the Jews should not have possessed the instrument, which the description in the *Talmud* seems to suggest. If we may accept the *Talmud* evidence, this latter will be the earliest literary reference that we have to the pneumatic organ, since earlier Greek, Roman and Byzantine writers only advert to the *hydraulis*

¹⁴ Jastrow, s.v. I take this opportunity of quoting the opinion of Professor D. S. Margoliouth, which he was good enough to express to me after he had read the MS. of the present work. He says: "In the matter of the *magrephah*, it would appear that the notion of its being a musical instrument is later than Rashi (d. 1105) and the author of the 'Aruch (c. 1100). *Tamid*, v, 6, deals with the removal of refuse from the Temple, and the *magrephah* is clearly an instrument or vessel in which such refuse is collected. . . . In the passage of 'Arakin, Rashi is clear that the same instrument is meant, . . . and adds the French *videlle*, which is now used for 'jagging iron,' but probably, in Rashi's time, meant something different. He says that it is exactly the shape of a hand, i.e., a pan with a number of spouts. These spouts he supposes furnished with holes somewhat similar to the mechanism of the silencer of a motor-car. The supercommentary called *Tosaphoth* finds fault with Rashi's view, and supposes that a musical instrument is meant, and it is true that the context here deals with musical instruments. The discursive nature of the *Gmara* renders this argument of little weight. According to Rashi, the music will have been accidental, and it may be suspected that the source of the whole story was *Psalm* xlii, 8 (7), 'Deep calleth unto deep at the noise of thy water-spouts.'"

¹⁵ Abdy Williams, *Aristoxenian Theory of Musical Rhythm*, 9. The *Talmud* tells us that the Jews had their Temple instruments of music repaired in Egypt, the home of the *hydraulis* and other instruments.

The Organ of the Ancients.

or hydraulic organ. Apart from the *Talmud*, the earliest reference to the pneumatic organ is that of Julian the Apostate (d. 363 A.D.).

§ 2.

Whilst there is no evidence that the pneumatic organ, i.e., the *magrephah*, was used by the Jews after the destruction of the Temple at Jerusalem (70 A.D.), there are a number of references to the *hydraulis*, which was known to the Jews as the *idrabilis* or *hirdaulis*,¹⁶ words perspicuously derived from the Greek. This instrument, as we have already apprehended, was of colonial Greek origin, and it (or some type of hydraulic organ) is mentioned by Greek and Latin writers such as Philōn (fl. 150 B.C.),¹⁷ Cicero (d. 43 B.C.),¹⁸ Severus (fl. 10 B.C.),¹⁹ Petronius (fl. 66 A.D.), Vitruvius (fl. 70 A.D.),²⁰ Pliny the Elder (d. 79 A.D.),¹ Suetonius (fl. 116 A.D.),² Nikomachos (fl. 138),³ Herōn (fl. 150),⁴ Julius Pollux (fl. 180),⁵ Athēnaios (fl. 220),⁶ Tertullian (d. c. 222),⁷ and Obstatianus (fl. 324),⁸ whilst the art remains which cover this period, the *hydrau-*

¹⁶ The corrected forms as given by Jastrow.

¹⁷ Philōn, 77. The dates of Philōn and Vitruvius have been adjusted in deference to the conclusions of Baron Carra de Vaux and Paul Tannery. The latest authoritative opinion on these dates is that of Sir Thomas L. Heath (*Hist. of Mathematics*) as follows. Philōn, end of second century B.C. Vitruvius, first century B.C. Herōn, third century A.D. Dreyer (*Planetary Systems*, 128) would place Vitruvius as late as 400 A.D.

¹⁸ Cicero, *Tusc.*, iii, 18. ¹⁹ Lampridius (Edit. Saumaise), 113.

²⁰ Vitruvius, x, 13. ¹ Pliny, *Hist. Nat.*, vii, 38, ix, 8, 1.

² Suetonius, *Nero*, 41 and 54. ³ Nikomachos (Meibom.), 8.

⁴ Herōn, sect. 42. ⁵ Julius Pollux, iv, 70.

⁶ Athēnaios, iv, 75. ⁷ Tertullian, *De anima*, xiv.

⁸ Wernsdorf, *Poeta latini minores*, ii, 406.

The Organ from Hebrew Sources.

lis of the Nero (54-68 A.D.),⁹ and Trajan (98-117)¹⁰ medallions, the Carthage statuette (c. 120),¹¹ the Nennig mosaic (c. 117-38),¹² the Caracalla medallion (211-17),¹³ the Julia Tyrrenia tomb (second-third century),¹⁴ the Villa Ludovisi fragment (fourth century),¹⁵ and the Valentinian III medallion (425-55),¹⁶ probably enable us to fix with some degree of definiteness, its external form. That all these designs actually represent *hydraules* we cannot be sure. At any rate, the external bellows that are shown in the Obelisk of Theodosius are not depicted, but there is no reason, however, why these should not have been manipulated in the same way as the pumps of the *hydraulis*, i.e., within the organ case.

Philōn tells us that in "the *syrinx* played with the hand which is called the *hydraulis*, the bellows . . . forced the wind into an oven (*pnigeus*) of bronze, which was in the water." What these bellows were like, we know from precise descriptions given by him in his *Pneumatics*, which has come down to us in the Arabic version entitled the *Kitāb fī'l-ḥiyāl al-rūḥāniyya*. Here we not only have the cylindrical piston, but also what must have preceded it, the collapsible cylindrical bellows called in Arabic the *sauqī* bellows, such as the goldsmiths used.¹⁷

This is the instrument whose invention is ascribed to Ktēsibios or Mürisṭus, in which the water functions as a

⁹ *Revue archéol.* (1890), p. 99. See also the gem in the British Museum given in Chappell, *Hist. Mus.*, p. 363.

¹⁰ Sabatier, *Descr. gén. des médaillons contorniates*, pl. x.

¹¹ Galpin, *Notes on a Roman Hydraulis*, in *The Reliquary*, 1904.

¹² *Revue archéol.* (1890), p. 98. ¹³ Sabatier, *op. cit.*, pl. x.

¹⁴ *Revue archéol.* (1890), page 100.

¹⁵ *L'Arte* (Rome, 1898), p. 112. ¹⁶ Sabatier, *op. cit.*, pl. x.

¹⁷ Carra de Vaux, *Philon de Byzance*, 213.

The Organ of the Ancients.

pressure stabiliser. Vitruvius describes the *hydraulis* at length, although, strange to say, he does not explain the function of the water. First there was a cistern or *ar[c]a* containing the water. In this cistern there was an inverted funnel (*infundibulum inversum* = *pnigeus*) standing on three legs on the bottom of the cistern, so as to allow room for the water underneath. From the side of the inverted funnel there were pipes through which the wind was forced by pistons into the inverted funnel, both the pipes and the pistons having valves to prevent the return of the wind. From the neck (*cervicula*) of the inverted funnel there was a pipe which conducted to a wind chest (*arcula*), which fed the organ pipes, via cross channels (*canales*) controlled by stopcocks. In the organ pipes were the "sliders" called *plinths*, which were connected with a lever mechanism not unlike our modern organ key action.¹⁸

Herōn tells us much about the same as Vitruvius, save that the key action is fully described, and, above all, the function of the water as a pressure stabiliser is explained. When superabundant wind was forced into the *pnigeus* or inverted funnel, the water within the latter was forced down, whilst the water without was forced up. It was the gravitating power of water seeking its own level that supplied a constant wind-pressure.¹⁹

Julius Pollux defined the *hydraulis* as a *syrinx* of bronze, but blown from underneath instead of from the

¹⁸ For a complete English translation of this section of Vitruvius, see Gwilt, 237, and Maclean, 221. For a design of the instrument, see Vossius, 100, which must be used critically. Maclean says: "Except for short extracts, the dissertation [of Vossius] on the Water Organ has never yet been reproduced in original." This is incorrect. It was reproduced in original by Ugolinus, *Thes. ant. sacr.*, xxxii.

¹⁹ For English translations see Greenwood and Maclean. For designs see Maclean, 223, and Chappell, 340.

The Organ from Hebrew Sources.

top of the pipes. The wind was supplied by bellows, whilst water gave stabilisation to the wind pressure. Athēnaios also explains that the organ-pipes sounded on account of the water being disturbed [from its level].

Such was the instrument known in the Byzantine and Roman Empires, and, considering the influence of Egypt (the home of the *hydraulis*) over Jewry,²⁰ we may surmise that this instrument was fairly well known to the Jews in the early centuries of the Christian era, if not earlier.

The earliest mention of the *hydraulis* by Jewish writers is in the *Babylonian Talmud* tractate, 'Arakin, ii, and in a *tosephta* to 'Arakin (i, 13), as follows:

"And Rabbi Shim'on ben Gamaliel says that the *hydraulis* (*hirdabulis*, *hirdaulis*)¹ was not in the Temple. What is the *hydraulis*? Abaye says it is a musical instrument (*tabla*) like the organ (*gurgrana*)."²

The name of Shim'on ben Gamaliel (fl. 135 A.D.) is of importance in this connection, as it has been said that "his decisions are founded on . . . an intimate acquaintance with the subject."³ He was a *Tanna* of the fourth generation and Principal of the Usha Academy. He belonged to an illustrious family of *Tannaim*, the first of whom was Rabban Gamaliel the Elder, whose son, Rabbi Yhudah I, was the compiler of the *Mishnah*.

Abaye, surnamed Nahmani (d. 338) was a Babylonian

²⁰ *Harvard Theological Review*, xviii, 23.

¹ Cf. Jastrow, s.v., Ugolinus, xxxii, 478, *Talmud Babli* (Warsaw edit.), *Tosephta* (Zuckermann edit.).

² *Tabla*, according to Rashi = "a bell," but it also stands, like the Greek and Latin words *organon* and *organum* for "a musical instrument." It also means "something square" (= *ταβλα*), and might therefore equate with *πλινθος*. See *ante*, pp. 5, 6, *plinthion aulētichon*. For *gurgrana*, see Jastrow, but cf. Ugolinus, xxxii, 478.

³ *Jew. Ency.*, xi, 348.

The Organ of the Ancients.

Amora and Principal of the Pumbeditha Academy. His arguments with Rabbah bar Huna are considered of importance.

In the *Palestinian Talmud*, tractate *Sukkah*, v. 6, a similar passage to the above occurs as follows:

"It is handed down by Rabban [? Rabbi] Shim'on ben Gamaliel,⁴ that there was no *hydraulis* (*irdablis*) used [in the Temple] at Jerusalem, because it interfered with the music (*n'imah*)."

"Enthusiasts are not wanting," says the late Dr. Stainer, "who would make us believe that this instrument [the *hydraulis*] was among those known and used by the Jews in their Temple."⁵ We are not told who these enthusiasts are, but it is quite certain that the Jews did *know* of the *hydraulis*. As for its *use in the Temple*, we have it denied by the two eminent authorities who have been quoted above. It happens, however, that the word *hydraulis* equates with *'ugab* in one place, and this may have prompted the idea that the Temple possessed the instrument. We read, for instance, in the *Babylonian Talmud*, tractate *Sukkah*, v. 6:

"Rabbi Shim'on ben Laqish says that the *'ugab* was the *hydraulis* (*irdablis*)."

Again, in the *Targums of the Hagiographa* (seventh-eighth century) the word *hydraulis* (*hirdaulis*)⁶ stands for *'ugab* in *Psalms* cl. 4, probably in conformity with Ben Laqish or the Septuagint *organon*.

The opinion is obviously erroneous. Shim'on ben Laqish (d. 275) was one of the earliest Palestinian

⁴ In the Latin translation of *Sukkah* by Ugolinus, this name is written Shim'on ben Laqish through a *lapsus calami*. Moïse Schwab, in his French translation, said to be *from the Hebrew*, repeats the slip in the Latin of Ugolinus!

⁵ Stainer, 132.

⁶ Cf. Jastrow, s.v.

The Organ from Hebrew Sources.

Amora'im. In his younger days he had been a gladiator in the circus, and it was here, probably, that he became acquainted with the *hydraulis*, which was one of the special appendages of the spectacle.⁷ It is likely, however, that his opinion was coloured by the Septuagint, and on a false inference that as *'ugab* = *organon*, and *hydraulis* = *organon*, therefore *'ugab* = *hydraulis*.

A very interesting reference to the *hydraulis* occurs (if it is to be trusted) in the great *Midrash* on *Genesis* called *Bereshith Rabbah*, a work "which occupies the first position among the *Midrashim* in virtue of its age and importance."⁸ Rabbi Hosha'yah (fl. 219) is generally credited with the authorship of the work in its original form, although the final redaction probably dates from the fifth century. The passage in *Bereshith Rabbah* runs:

"There are *hydraules* players (*idrablin*) and flute players (*korablin*) in the land, and such a land should be destroyed."⁹

From this *midrash* it appears that the *hydraulis* was common in secular life among the Jews, just as it was in Colonial Greece and Rome. Here we have the condemnation of instruments of music, especially those linked up with the vanities of the world. This was due to the wave of asceticism that swept over Judaism after the fall of Jerusalem. The connection of the *hydraulis* players with the circus, and the unsavoury reputation of flute-players, especially female performers, seem to have aroused the ire

⁷ Daremberg et Saglio, ii, 1594. ⁸ *Jew. Ency.*, viii, 557.

⁹ *Korablin* is Jastrow's reading, and it equates with the Greek *choraules*. It appears in corrupted forms as *sorbalin* and *borbalin*. Jastrow also suggests that *idrablin* and *korablin* may stand for the instruments themselves and not the players, and may be read *organ* and *cymbals* (*κρεμβαλα*). See Bartoloccius, 479.

The Organ of the Ancients.

of the rabbis. The name *zimri* (wood-wind player) came to stand for a "lewd person,"¹⁰ just as in Arabic during the early days of Islām the term *zammāra* (female *zamar* player) came to be a euphemism for courtesan.¹¹ It was precisely the same sort of thing that operated in Western Europe when Christianity frowned on musical instruments.¹²

Elias bar Shinaya (b. 975), the Syriac lexicographer, tells us that the type of music which the *mukhannathūn* played was called *hydraulis* (*hedhrula*). The *mukhannathūn* among the Arabs were a shunned class, and the drum called the *kūba*, used by them in their orgies, became *anathema*.¹³ It would seem, therefore, that these *mukhannathūn* used the *hydraulis*, a circumstance which would lead to the condemnation in the above *midrash*.

NOTE.—Concerning the *Magrephah* of 'Arakin, Kathleen Schlesinger (*Researches*, 202) says that the only available translation, that of Moïse Schwab, of the passage in the *Talmud* concerning this instrument was so obscure that she had to fall back on the description by Kircher. The passage cannot have been obscure because the tractate 'Arakin does not appear in the *Palestinian* or *Jerusalem Talmud* which Schwab translated. It is only to be found in the *Babylonian Talmud*, which was available in a translation by Dr. August Wünsche (*Der Babylonische Talmud*, Leipzig, 1886-8; Berlin, 1894). Of course, Ugolinus had already given a Latin translation of all the passages on the *magrephah* in the *Talmud*.

¹⁰ *Talmud Yrushalmi*, Ta'anith, iii, 66.

¹¹ See my *History of Arabian Music*, p. 45.

¹² Tertullian, *De Spec.*, x. For the *ambubaia* see Papias, *Onom.*, s.v. Horace, *Epist.*, i, 14. *Sat.*, i (ii), 1.

¹³ See Freytag, *Lexicon*, sub "khanatha."

CHAPTER IV.

THE ORGAN FROM SYRIAC SOURCES.

"En dehors de ces très grandes orgues, on en fabriquait de petites, portatives, introduites en Occident sous le règne de Charlemagne par les ambassades byzantines. Il paraît même hors de doute que les facteurs des premières grandes orgues d'Occident, au ix^e siècle, étaient des Grecs ou des Syriens."—Amédée Gastoué, *La musique byzantine*.

IN spite of the mediocrity which Renan said was characteristic of the Syrians, it is to these people that we owe the passing on of the learning of ancient Greece to the Arabs of the Middle Ages, who, in turn, were to light the torch of civilisation anew for Europe. In music, at any rate, the comment of Renan is not altogether just. The Greeks of old borrowed many of the ideas of their instruments of music from the Syrians,¹ and in a similar way the Romans were also indebted to these Semites.² The influence of the Syrian cities of Antioch and Edessa, and of the Syrian poets, Synesius and Ephraem, on the early Christian Church,³ cannot be ignored, because of an epigram of Renan. Nor can we forget that Porphyry, Iamblichos and Theodoret came from Syria.

It was the Syrians who kept many of the ancient Greek sciences alive until the days of Islām. It was then that

¹ *Frag. Hist. Graec.*, iii, 481, 73. *Athēnaïos*, iv, 77, 78.

² *Juvenal*, *Sat.*, iii, 6.

³ *Rowbotham*, iii, chap. iv.

The Organ of the Ancients.

many of the ancient writings on the mechanical arts, including those on organ construction, were turned into Arabic by Syrian and Arab translators. Indeed, that there were books on the *hydraulis* in Syriac, appears to be hinted at by the ninth century Syriac lexicographer, Isho' bar 'Ali.⁴

§ 1.

Whatever the *magrephah* of the Jews was like, we probably get some idea of the pneumatic organ of the early Christian era in the oft-quoted Obelisk of Theodosius (d. 393),⁵ and the portative in the Orange medallion.⁶ Descriptions of the instruments are given by Julian the Apostate (d. 363),⁷ St. Augustine (d. 430),⁸ Theodoret (d. 457),⁹ and Cassiodorus (d. 585).¹⁰ Julian tells us of metal pipes, bull's hide bellows, and "sliders." St. Augustine depicts an instrument that is "large, and inflated by means of bellows." Theodoret (a Syrian) specifies metal pipes, leather bellows, and the fingers for playing. Cassiodorus speaks of pipes, bellows, "sliders" (*linguæ*), and the fingers, for playing.

⁴ Payne Smith, 977.

⁵ See the instrument delineated by Hopkins and Rimbault (*The Organ: Its History and Construction*, p. 16), Chappell, *Hist. of Music*, p. 373. Naumann, *Hist. of Music*, i, 194. Grove's *Dict. of Music*, iii, 737. Cf. Didron, *Annales archéologiques*, iii, 277. Reinach, *Bibl. des monum.*, i, 127. Kathleen Schlesinger (*The Organ*, 267) considers the instrument of the Church of St. Paul at Rome (fourth-fifth cent.) to be a pneumatic organ, but there is no reason why it should be thus designated.

⁶ Kathleen Schlesinger classes this as a pneumatic organ, although others say that it is an *hydraulis*. *Dict. d'arch. chrét.*, vii, i, 1186. See also De Caylus, *Recueil d'antiquités*, ii, 14.

⁷ Brunck, *Analecta*, ii, 402.

⁸ Migne, *Patr. Lat.*, xxxvi, 671. xxxvii, 1964.

⁹ Migne, *Patr. Lat.*, iv, 590.

¹⁰ Migne, *Patr. Lat.*, lxx, 1052.

The Organ from Syriac Sources.

We frequently read of organs in Byzantium, where we know, from Syriac sources, that they were used by the emperors at their festivities,¹¹ and Justinian II (d. 711) is said to have been cured of his madness by the soothing effects of the organ.¹² In 757, the Emperor Constantine Copronymus presented Pépin, King of the Franks, with an organ.¹³ Wonderful organs of silver and gold are mentioned in the accounts of the festivities during the visit of the Arab ambassadors to the Byzantine court of Constantine Porphyrogenitus (d. 959),¹⁴ and it is an instrument of this period that is described by the Syrian author named Isho' bar Bahlul (fl. 965). Here is his description of the pneumatic organ:¹⁵

This organ (*urganun*) "consists of two columns, hollow and slender; beautifully made of marble. And these stand upright, closely united in a skilful way. Below are bellows similar to those which a blacksmith uses, although not so large, but small and elegant. The organist sits above, and those who perform the song, whatever it may be, stand on the right and left, and sweet music (*zemara*) is heard, to which there is nothing similar in creation. They say that such [an organ] is in that church [St. Sophia] in Byzantium [Constantinople]."

Some of the above details are interesting. Whilst there is no reference to the pipes, the mention of the two marble columns leads one to suppose that these were the pillars which supported the organ-case.¹⁶ This appears to be

¹¹ See also Greek sources: *Patr. Græc.*, cxii, col. 73, cxxvii, col. 400, clvii, col. 85, clviii, col. 537.

¹² Payne Smith, 91.

¹³ *Mon. Germ. Hist.*, i, 140.

¹⁴ Thibaut, 174-5.

¹⁵ Payne Smith, 91.

¹⁶ Pneumatic organs of the sixth and ninth century are shown by Gerbert, *De cantu*, ii, tab. xxiii, xxvii. Those of the tenth century may be seen in Buhle, pl. 14.

The Organ of the Ancients.

the only Syriac reference to the pneumatic organ in the Middle Ages, although we have occasional mention of the *hydraulis*, and to this instrument we now turn.

§ 2.

In spite of the *anathema* hurled against the *hydraulis* by Judaism and Christianity, the instrument found favour until the fifth-sixth century. In the West, it is referred to by Claudianus (fl. 395 A.D.),¹⁷ Martianus Capella (fl. 480),¹⁸ and Apollinaris Sidonius (d. ca. 483).¹⁹ An important reference to the *hydraulis* is to be found in a Syriac author of the fifth century named Isaac of Antioch (d. ca. 460). He was "one of the stars of Syriac literature,"²⁰ who lived at Antioch as a priest and abbot until 459. His works have been published in Syriac with a Latin translation by Gustavus Bickell, and among them is a poem which introduces the *hydraulis*. It is of sufficient interest to be quoted at length.¹

"A wave of meditation rushed in upon me, and threw me from place to place, even now to that island of dry land which is situated in a sea of sand, yea, even to the lovely city of the Greeks, which I entered, having set out from the East to the Western Sea.

"During the month of *Kanun*, which, by music, is depriving the inhabitants of sleep, I was hearing every night the sounds of citharas (*qithara*), hydraules (*hedhrula*), symphonias (*ṣphunutha*), which resounded before the palaces of the princes.

¹⁷ *De consulatu Fl. Mallii Theodori*, line 316.

¹⁸ Mart. Cap., *De nupt.*, 594.

¹⁹ Apoll. Sid., i, 2. For designs see Ruelle, 316. Leclercq, 1179.

²⁰ Wright, *Syr. Lit.*, 51. ¹ Isaac of Antioch, i, 295.

The Organ from Syriac Sources.

"At a time when sleep is sweet, nevertheless music was distinctly audible. The braying sound of the horns (*qarna*) subjugated sleep. On the contrary, the feet trod so quietly without any commotion, that the steps of those walking feet were not heard, and every loud noise was entirely driven away by the silence, and the necessity of listening to the cithara.

"The whole city was like a tavern, and, with the musical plays, they changed night into day. Everyone devised and learned melodies on every scheme, so that each was pleased with his own voice, and was delighting himself with his singing. The mouths of the shepherds vied with the citharas, and the voices of the tragedians strove to overcome the lyres (*kennara*).

"This month of *Kanun* again reminded the city of the different ranks in it, for on none of the nights was music neglected under the windows of the judges, or before the gates of the princes. Every night, instruments, musical feasts, as it were, were set out in order. Nothing fails with a *hydraulis* if there be a performer. With mere rational speech, man overcomes the cithara. Musical instruments are like men without speech or reason. Their strings are compressed as if they were eager to speak; nay, rather, if they are played by persons that can speak, they also receive a certain kind of speech or reason. They wish to utter prompt oratory, but the tongue is deficient in articulation. Their voices are like the voice of a man who wishes to tell a story conceived in the mind, but is abandoned by the lips and tongue.

"In this way, the destitute, anticipating the dawn, sing before the palaces of the rich, and spend tiresome watches so as to flatter the proud. Tongue is joined with reed-pipe (*abbuba*), and the lips of the *hydraulis* with its low

The Organ of the Ancients.

sound, sustains the soft voices, and, united with them, the singing can reach to the top of the palaces. It [instrument] the mute, is joined with the articulate [man], whose voice is heard far and wide. The sweet concord which I then heard was wonderful. Moreover, on a certain day there, when we were immersed in slumber, the *hydraulis* sounded loudly, so that being terrified on hearing it, I awoke. Then my brethren who were with me, and I, arose straightway to perform our duty, and a psalm which best suited the occasion occurred to us."

This narration is quite an important adjunct to the historical literature of the *hydraulis*, since it tells us more than any of the Greek or Latin authors do of the intimate part which this instrument played in the lives of the people.

After this reference by Isaac of Antioch (d. ca. 460) and that of the *Talmud*, nothing is heard of the *hydraulis* in the East for over three centuries. The same thing occurs in the West, where, after Apollinaris Sidonius (d. ca. 483), we have silence concerning this instrument until the ninth century. It may therefore be assumed with a tolerable degree of certainty, that the *hydraulis* had disappeared in the interim.

The disuse of the *hydraulis* appears to have been due to three factors: (1) the triumph of the barbarians; (2) the rise of Christianity and of a puritanical Judaism; and (3) the greater simplicity in construction of the *pneumatic organ*. Whilst Gaul and Italy experienced the barbarian devastations which materially contributed to what has been termed the "Dark Ages," Byzantium was not so badly exposed, and here, probably, only the second and third causes operated. That the arts and sciences, including music, were held in contempt by the early Chris-

The Organ from Syriac Sources.

tians, is testified by many authorities, but there is an interesting confirmation from a Muslim source. It occurs in the *Murūj al-dhahab* of Al-Mas'ūdī (d. c. 956), where we are told as follows. In the days of the ancient Greeks, and in the first period of the Kingdom of Byzantium, science was developed, and scholars were honoured. . . . Then came the Christian religion, which became fatal to scientific knowledge, since it destroyed and blotted out the teaching of science. All that the ancient Greeks had placed before the world vanished or was distorted. Among the noble sciences which were thrown aside with the advent of Christianity was the science of music.²

Puritanical Judaism was equally contemptuous of instrumental music, as we have seen.³ The *hydraulis*, above all other instruments, savoured of the circus, the spectacle, and all the so-called orgies of Paganism, against which the Christian Fathers and Jewish Rabbis alike had sternly set their faces. When next we read of the organ, it is no longer of the *hydraulis*, but of the pneumatic organ.

Probably the art of constructing the *hydraulis* was lost in the barbarian destruction of the writings of antiquity, and also by reason of the ignorance of the Christian monks. Vossius opined that the barbarians tried unsuccessfully to make the *hydraulis*, but had to remain content with the pneumatic organ, which was more easily constructed. On the other hand, it may have been that the latter instrument was free from *anathema*. Certainly, it was much easier to make and less liable to get out of order.

After the world-wide Arab conquests of the seventh-eighth centuries, and the consequent revival of learning,

² Al-Mas'ūdī, ii, 320.

³ See *ante* pp. 43-4.

The Organ of the Ancients.

we read once more of the *hydraulis* in Syriac writings.⁴ This occurs first of all in the lexicographer, Isho' bar 'Ali, who is said to have been a pupil of Hunain ibn Ishāq (d. 873), a Christian Arab of Al-Ḥīra, and one of the savants of the *Bait al-ḥikma* (College of Science) in Baghdād. Isho' flourished at Baghdād, where his father and uncle were in charge of the college in the Mar Pethion Convent in 832-6. Isho' defines the *hydraulis* (*hedhrula*) thus:

"[It is] the organ (*urghanun*) . . . skins,⁵ on which they play."

The Arabic commentary on this passage says:

"[It is] the organ (*urghānun*, *urghānūn*) on which one plays."

Another Syriac lexicographer, Bar Saroshwai (early tenth century) says:⁶

"*Hydraules* are instruments of music on which one plays, such as reeds (one MS. has 'skins') which men work."

The more celebrated Isho' bar Bahlul (fl. 963) describes the *hydraulis* a little closer:

"The *hydraulis* of brass is explained as a certain oven (*tannur*)."⁷

The Arabic commentary on the passage runs:

"[It is] the musical skin (bag), the organ (*urghanun*)."

Payne Smith, the famous Syriac scholar, thought that this mention of the *tannur* (oven) was an error. It is not, since this same word is mentioned in the Mürisṭus Arabic treatise on the *hydraulis*, and equates with the *bōmiskos* of Herōn and the *ar[c]a* of Vitruvius.

⁴ Payne Smith, 977-8.

⁶ Payne Smith, loc. cit.

⁵ Meaning the "bellows."

⁷ Payne Smith, loc. cit.

The Organ from Syriac Sources.

Elias bar Shinaya, of Nisibis (b. 975) says:⁸

"*Hydraules* are instruments which they play like reeds and what resembles these."

The Arabic commentary runs:

"[It is] the musical skin (bag), like the flutes (*shabab*) and wooden contrivances (*manjar*), and the like."

These later notices anent the *hydraulis* from Syriac sources are probably too fragmentary to be of much use to historians of music, but at least they enable us to recognise that the Syrians knew of the instrument in the ninth-tenth centuries, and we must remember that the famous *Utrecht Psalter*, which gives us the first pictorial evidence of the *hydraulis* since the fifth century, was probably inspired by Syrian art or artists. Further, it was in Syria that Arabs were constructing organs in the twelfth century.⁹

⁸ *Ibid.*

⁹ Ibn Abi Uṣaibi'a, ii, 155, 163.

CHAPTER V.

THE ORGAN FROM ARABIC SOURCES.

(THE PNEUMATIC ORGAN.)

"Harp and Tambourine and Organ, dulcimer-like sweet resound,
For the sigh of Flutes is Frankland all awail, in verity."
Prince Jem of Turkey (d. 1495).

IN the Muslim conquests of Persian and Byzantine lands in the seventh-eighth centuries, we see that first harbinger of the dawn whose meridian was the Renaissance. In the fourth century B.C., Greek science had marched with Alexander the Great into Syria, Mesopotamia and Persia, where it subsisted even down to the Christian era in important culture centres like Edessa, Harrān and Jundēshāpūr. Yet, it was not until the Arabian khalifs took Greek science under their protection that it came to flourish in the Middle Ages. The Umayyads (661-750) were certainly interested in the question, but it was reserved for the 'Abbāsids (750-1258), beginning with Khalif Al-Manṣūr (754-75), to rescue the learning of the Ancients from the oblivion engendered by the Dark Ages.¹

The libraries of Byzantium were searched for the sciences of the Greeks, and a host of treatises were translated from the Greek into Arabic, many, if not most of

¹ Wenrich, x-xiii, xxi-xxiv.

The Organ (Pneumatic) from Arabic Sources.

them, via Syriac. Works on the propædæutic or mathematical sciences ('ulūm riyāḍiyya), which comprised arithmetic, geometry, music and astronomy, may be traced in Arabic to the eighth century, when we have the 'Arḍ miftāḥ al-nujūm of Hermes being translated into Arabic (dated 743).²

It was, however, the Baghdad College of Science (*Bait al-ḥikma*), founded by Khalif Al-Ma'mūn (813-33) that speeded the work of translation, and it was here that one at least of the works on organ construction which has come down to us, that of the Banū Mūsā, was produced. Baron Carra de Vaux is of opinion that the mechanics of the Greeks, as well as their music, was studied, first of all, on Persian territory, before it passed into the hands of the Arabs.³ Certainly, the number of Persian technical words which are to be found in the Arabic works on mechanics and similar sciences, are considerable, although both Aramaic and Syriac are well represented.

Concerning the present subject we find that there were Arabic translations of the *Pneumatics* of Philōn (*Kitāb Fīlān fīl-ḥiyāl al-rūḥāniyya wa mikhāniqā al-mā'*), the *Mechanics* of Herōn (*Kitāb al-ḥiyāl al-rūḥāniyya*), and the *Automatic Wind-Instrumentalist* (*Ṣan'at ālat al-zāmīr*) of Archimedes and Apollonius of Perga. These works show us that the Arabs were fairly well acquainted with these departments of science, and especially with the production of musical sounds from flue and reed-pipes by means of hydraulic action.

In all probability, these translations were done in the ninth century. Philōn's *Mechanics* was probably trans-

² See my *Historical Facts for the Arabian Musical Influence*, p. 272 et seq.

³ Carra de Vaux, *Philon de Byzance*, 40.

The Organ of the Ancients.

lated in the time of Al-Ma'mūn (813-33).⁴ The Herōn treatise came from the hand of Qusṭa ibn Lūqā, and was written for Khalif Al-Musta'in (862-66). The translation of Apollonius of Perga may be due to Hilāl ibn Abi Hilāl (d. c. 882) or Thābit ibn Qurra (d. 901).⁵

As for the organ proper, we have evidence that it was in use by the Arabs in 813-25, as we shall see presently. Yet precisely how it came to be adopted by them we do not know. In Syria, and in Byzantine lands, the Arabs would have come in contact with the pneumatic organ as early as the seventh century, when they conquered Syria and a portion of Asia Minor. In the eighth century, several mechanical contrivances of the Byzantines and Ancient Greeks were adopted by the Arabs, and the pneumatic organ may have been one of them. It is more likely, however, that it was not until the Syro-Arabian school of translators began to work on the ancient Greek treatises on organ construction, that the Arabian mechanicians themselves began to produce this instrument for the khalifate court and nobility, who were always interested in musical and mechanical novelties. At any rate, it is fairly certain that the *hydraulis* made its appearance in this way, that is to say, that it was not until the ancient Greek works on the *hydraulis* became known to the Arabs, that the instrument was revived anew, after having been neglected for two or three centuries.

The earliest technical documents dealing with organ construction in Arabic are those attributed to a certain Mūristus, to whom we have already referred. That these are translations or compilations from Greek documents, there is every reason to believe. We do not know, how-

⁴ Carra de Vaux, loc cit.

⁵ See the *Fihrist*, 267, 285.

The Organ (Pneumatic) from Arabic Sources.

ever, the precise date of their transmission. Assuredly, they were known to the polygraph, Al-Jāhiz (d. 868).⁶ Père Cheikho suggests that the translation or compilation was done by one of the Banū Mūsā (Muḥammad died in 873), or by Ḥunain ibn Isḥāq (d. 873). Yet since the organ was known to Al-Mahdī's daughter 'Ulayya (d. 825), an earlier date is almost incumbent upon us, if we are to accept the suggestion that the organ was introduced to the Arabs via the literary contact.

We can now deal with the various types of mechanically wind-fed instruments that were known to the Arabs. (1) the *Pneumatic Organ*, (2) the *Hydraulic Organ* (hydraulic air compressor), and (3) the *Hydraulis* (hydraulic pressure stabiliser).

§ 1.

The earliest definite reference to the word *organ* in Arabic is to be found in the famous *Kitāb al-aghānī*, or "Book of Songs," by Abū'l-Faraj al-Iṣfahānī (d. 967), who quotes a story about Khalif Al-Ma'mūn, Ismā'il ibn al-Hādī, and 'Ulayya, the daughter of Al-Mahdī. Since Al-Ma'mūn became khalif in 813, and 'Ulayya died in 825, the incident must have taken place between these dates. Although the *organ* is merely mentioned, the story is too good to be passed over, and we therefore give it.⁷

"There informed me Muḥammad ibn Yaḥyā, on the authority of 'Awn ibn Muḥammad, on the authority of Abū Aḥmad ibn al-Rashīd, and [in addition] I copied the story from a book by Muḥammad ibn al-Ḥasan, who got it from 'Awn ibn Muḥammad, who got it from Abū Aḥmad ibn al-Rashīd, the following: He [Muḥammad

⁶ Al-Jāhiz, 133, 143.

⁷ *Kitāb al-aghānī*, ix, 90 (Sāsī edit.).

The Organ of the Ancients.

ibn Yahyā] said, Ismā'il ibn al-Hādī entered one day into the presence of Al-Ma'mūn, when he heard music (*ghinā'*) which diverted his attention. Then Al-Ma'mūn said to him, 'What ails you?' He replied, 'I have heard something that has bewildered me, and yet I have been the most strenuous in denying that the Byzantine organ (*urghan al-rūmī*)⁸ killed with delight, but now I declare that to be true.' He [Al-Ma'mūn] said, 'Do you not know what this is [that you have heard]? He [Ismā'il] replied, 'No, by Allāh.' He [Al-Ma'mūn] said, 'It is your aunt 'Ulayya, who is teaching your uncle Ibrāhīm [ibn al-Mahdī] to sing a melody from her repertory.'"

The Arab historian, Al-Mas'ūdī (d. c. 956) has an interesting passage on Byzantine musical instruments in his *Murāj al-dhahab*, which mentions the organ. The passage is actually a citation from an oration by Ibn Khurdādhbih (d. 912) before Khalif Al-Mu'tamid (870-93). This Ibn Khurdādhbih had some reputation as an authority on musical instruments, and was the author of two books on music, a *Kitāb adab al-samā'* ("Book of Liberal Education in Music") and a *Kitāb al-lahw wa'l-malāhī* ("Book of Diversion and Musical Instruments"). In his oration, Ibn Khurdādhbih says:⁹

"And they [the Byzantines] had the *urghanun* possessing bellows and iron work."¹⁰

A more precise description of the Byzantine organ is given by an Arab-Persian scholar named Ibn Rusta, who

⁸ The text, in both the Būlāq and Sāsī editions, has *ur'an*, i.e., with an 'ain instead of a ghain.

⁹ Al-Mas'ūdī, viii, 91-2.

¹⁰ The Cairo text has *urghanīn*. See also my *History of Arabian Music*, 169, my *Studies in Oriental Musical Instruments*, 60, and *J.R.A.S.*, 1926, p. 92.

The Organ (Pneumatic) from Arabic Sources.

lived at Iṣfahān in the ninth-tenth century. Particulars of his life are wanting, but we know that he was at Al-Medīna in 903, and that about the same time he wrote a work entitled the *Kitāb al-a'lāq al-nafīsa*, the geographical portion of which has survived.¹¹ Ibn Rusta describes an organ at Constantinople as follows:¹²

"Then there is brought a thing called an organ (*ur-qanā*), and it is made of a square [case of] wood, in the shape of a wine-press (*ma'sara*), and this latter is covered with strong skin. Then there are made in it sixty pipes of brass, the heads of which, as far as the middle, project above the case. These pipes are covered with gold above the case, with the exception of a small portion, in proportion to their sizes, one longer than the other.

"At the side of this square thing [the case] are holes in which are fixed the bellows (*minfakh*), which resemble the blacksmith's bellows (*kūr*). Then there are brought three crosses (*ṣalbān*); two are placed on the ends, and one in the middle. Then they press the bellows with the feet, and the organist (*ustādh*) stands and plays (*ḥasaba*) upon these pipes, and each pipe he makes to speak in turn, according to what he [the organist] plays."

Another description of the Byzantine organ is given in the encyclopædia known as the *Mafātīḥ al-'ulūm*, or "Keys of the Sciences," written by Muḥammad ibn Aḥmad al-Khwārizmī about the middle of the tenth century. In the section on "Musical Instruments" we are told:

"The organ (*urghānūn*) is an instrument of the Greeks (*Yūnāniyyūn*) and Byzantines (*Rūm*). It is made of

¹¹ The text has been printed by De Goeje in his *Bibliotheca Geographorum Arabicorum*.

¹² *Bibl. Geog. Arab.*, vii, 123.

The Organ of the Ancients.

three large bags of buffalo skins, one being joined to another. And there is mounted upon the head of the middle bag, a large skin.¹³ Then there are mounted upon this skin, brass pipes having holes upon recognised ratios, from which proceed beautiful sounds, pleasing or melancholy, according to what the player desires."¹⁴

The 'large skin' upon which the brass pipes were mounted would appear to have been used for the same purpose as our modern horizontal bellows.

It is in the ninth century that we first hear of the name of Mūrīṣṭus from Arabic sources. This was the supposed inventor of the organ, and/or the author of works on organ construction. He is mentioned by the famous polygraph, Al-Jāhīz (c. 773-868), the companion of Ibn al-Zayyāt, the wazīr of Khalīf Al-Wāthiq.¹⁵ The first actual reference to the titles of the works of Mūrīṣṭus, however, occurs in the *Fihrist* of Ibn al-Nadīm, written in the year 988. This writer says:¹⁶

"Mūrṭus or Mūrīṣṭus. And among his books are, Book on the Musical Instruments called the Flue-pipe Organ (*urghānūn al-būqī*) and the Reed-pipe Organ (*urghānūn al-zamrī*); Book on the Musical Instrument which may be heard Sixty Miles."

A similar passage occurs in the *Ta'rikh al-ḥukamā'* of Ibn al-Qiftī (d. 1248):¹⁷

"Mūrṭus or Mūrīṣṭus, a Greek sage, skilled and ingenious. And among his literary works is a Book on the Musical Instrument called the Flue-pipe Organ and the Reed-pipe Organ which may be heard Sixty Miles."

¹³ One MS. has "small skin" instead of "large skin," but Ḥājī Khalifa (vi, 258) has "large skin."

¹⁴ Al-Khwārizmī, 236.

¹⁶ *Fihrist*, 270.

¹⁵ Al-Jāhīz, 133.

¹⁷ Ibn al-Qiftī, 322.

The Organ (Pneumatic) from Arabic Sources.

Lastly, the passage may be found, with a slight variation, in the *Ta'rikh mukhtaṣar al-bashar* of Abū'l-Fidā' (d. 1331):¹⁸

"And among them [the Greeks] was Mūrṭus or Mūrīṣṭus, a Greek sage, skilled and ingenious. And he composed a 'Book on the Instrument called the Organ (*urghān*), and it is the instrument which may be heard Sixty Miles.'"

This Mūrṭus or Mūrīṣṭus, was also the author of a *Kitāb ṣan'at al-juljul* ("Book on the Construction of the Chime"),¹⁹ the Arabic text of which has been printed in the *Mashriq*.²⁰ In this work we read of a certain Sā'āṭus¹ as a constructor of this chime. He is also mentioned in the *Fihrist* as the author of a *Kitāb al-juljul al-ṣiyyāh* ("Book of the Octave Chime"),² and he is another Greek or Byzantine writer, whose work, although unknown in Greek, has been preserved in Arabic.

Returning to Mūrīṣṭus, it is not improbable that three other works mentioned in the *Fihrist* may be attributed to him. They are: a *Kitāb ālat al-zamr al-būqī* ("Book on the Trumpet-like Reed-pipe"), a *Kitāb al-zamr al-rīḥī* ("Book on the Æolian Reed-pipe"),³ and a *Kitāb al-dawālib* ("Book on Water-wheels").⁴

¹⁸ Abū'l-Fidā', 156.

¹⁹ The Bairūt text has *ṣuffa*, but the Catalogue of the MSS. in the Université de Beyrouth in the *Mélanges de la Faculté orientale* (vii, 289) has the word *ṣan'at*, as in the British Museum MS. Cf. *Mashriq*, ix, 19.

²⁰ For a German translation of this see Wiedemann's *Byzantinische u. arabische akustische Instrumente*, 164.

¹ The Bairūt text has Sāṭus, but the British Museum and Constantinople MSS. have Sā'āṭus.

² It may be read *ṣayyāḥ* ("clamorous").

³ At Ṣan'a in Al-Yaman there were statues that were made to sound by means of pipes through which the wind passed. (Yāqūt, iii, 811.)

⁴ *Fihrist*, 285.

The Organ of the Ancients.

It may be safely conjectured that Ibn al-Qiftī derived his information from Ibn al-Nadīm, or else that both depended on a common source.⁵ At the same time it must be noticed that Ibn al-Nadīm refers to two books whilst Ibn al-Qiftī and Abū'l-Fidā' only mention one. Further, Ibn al-Nadīm refers to two distinct instruments, a Flue-pipe organ and a Reed-pipe organ, whilst the others speak of a single instrument combining both types of pipe. Such contrariety, however, may be due to the carelessness of copyists, and we certainly have no other evidence of the combined instrument.

It has already been pointed out⁶ that there are several specimens of the Mūristus MSS. on the pneumatic organ and *hydraulis*. In the British Museum (Or. 9649) these are entitled: (a) *Risāla li-Mūristus ṣan'at al-urghīn al-būqī* ("Treatise by⁷ Mūristus on the Construction of the Flue-pipe Organ"), and (b) *Risālat ukhrā li-Mūristus ṣan'at al-urghīn al-zamrī* ("Treatise also by Mūristus on the Construction of the Reed-pipe Organ"). The Constantinople MSS., which are preserved in the Library of St. Sophia (Nos. 2755, iii and iv) have similar titles except that the phrase *al-ḥakīm* (the sage) is added to the name Mūristus.⁸ The copies (No. 224) at the Catholic University of Bairūt appear to be copies of the Constantinople MSS., and they are included in the one title: *Risālatān li-Mūristus fī l-urghanun* (Two Treatises by Mūristus on the Organ).⁹ Perhaps the oldest copies (No. 364) are those preserved at the Three Moons College of the Greek

⁵ Abū'l-Fidā' certainly borrowed from Ibn al-Qiftī.

⁶ See *ante* pp. 16-17.

⁷ See *ante* pp. 17-18.

⁸ Carra de Vaux, *Philon de Byzance*, 30.

⁹ Cheiko, *Cat. rais.*, vii, 289.

The Organ (Pneumatic) from Arabic Sources.

Orthodox Church at Bairūt. Here, the works are called: (a) *'Amal al-ālat illatī ittakhadhahā Mūristus yadhhabu ṣautuhā sittin milan* ("Making of the Instrument which Mūristus Invented, the Sound of which Travels Sixty Miles"), and (b) *Ṣan'at al-urghan al-jāmi' li-jāmi' al-aṣwāt* ("Construction of the Comprehensive Organ for all the Sounds").¹⁰ This is the only copy of the Arabic work on the *hydraulis* which expressly mentions Mūristus as the "inventor."

For the present, however, we are concerned with the *pneumatic organ*, and the Mūristus MS. deals with a type of instrument much earlier than anything hitherto known to us. Although the Arabic texts of the Bairūt Mūristus MSS. have been printed in the *Mashriq*, they are faulty, and the present translation is based on the British Museum MS. which has not hitherto been used. At the same time, both the *Mashriq* texts and Professor Wiedemann's German translation have been used in collating the British Museum text for the purpose of the present translation.

"TREATISE ALSO BY MURISTUS ON THE CONSTRUCTION OF THE COMPREHENSIVE REED-PIPE ORGAN FOR ALL THE WONDERFUL SOUNDS.

"And it is that which makes you hear a wonderful sound, causing you to weep violently: And makes you hear a sound compelling sleep, for he who hears it sleeps where he stands: [And makes you hear a sound so as to grieve and divert:]¹¹ And makes you hear a sound so as

¹⁰ *Mashriq*, ix, 19.

¹¹ Not in the Brit. Mus. MS.

The Organ of the Ancients.

to be merry and to dance:¹² And makes you hear a sound that enchants and carries away the senses.¹³ So when you wish to make this instrument, take three skins (*ziqq*)¹⁴ tanned well and soft, each of them separately, and do not let bitumen (*zift*)¹⁵ come near them. Then, sew up the heads of two of these skins thoroughly, so that they are air-tight, and leave the third skin with its head unsewn. Then put the skin that has its head unsewn in the middle, and each of the other two skins on the right and left of it. Then, perforate the [inner] side of each skin that is on the right and left of the middle skin with four holes, and similarly perforate the middle skin on its two sides with four holes exactly opposite to the holes of the two skins on either side of it. Then these three skins are marked: A, B and J. And the middle skin is B.

"Then take pipes (*unbūb*) of strong brass (*naḥās*), about the thickness of a [big]¹⁶ tube (*qaṣīb*)¹⁷ the length of each pipe being 54 cm. (= 1 *dhirā'*). Then, let them be joined from skin to skin. And these pipes are called 'the passages of the wind.'¹⁸ And let these holes and these pipes be of different size in their measure and arrangement, according to ratio, and according to what I shall describe.

"Let the first hole of the right [skin] which is opposite the breast (*ṣadr*) of the middle skin, be measured according to what we wish of the dimension of width. And

¹² Cf. Wiedemann.

¹³ Cf. Wiedemann.

¹⁴ A *ziqq* (pl. *ziqāq*) says Al-Laiṭh ibn Muḥaffar (eighth cent.) is a skin in which the hair has been clipped off, not plucked out.

¹⁵ A preparation for wine skins. ¹⁶ Not in the *Mashriq* text.

¹⁷ The Constantinople MS. also has *qaṣīb*, but the *Mashriq* had *qaḍīb* (a stick).

¹⁸ The *Mashriq* text has, "are for the passage of the wind."

The Organ (Pneumatic) from Arabic Sources.

this [dimension of the first hole] is the starting-point of the dimensions, and similarly the width of its pipe. This is the pipe [marked] D. And the second [which is next to it]¹⁹ is double the first in its measurement, and this is the pipe marked H. And the third is three times the quantity of the first, and this is the pipe marked W. And the fourth is four times the quantity of the first, and it is the pipe marked Z. And similarly, the width of the pipes to be the width of the holes. So understand that.

"And let the holes of the skin which is on the left be according to this ratio. If the width of the first hole of the [left] skin [be like]²⁰ the width of the first hole of the first skin on the right, then likewise the ratios of the remainder. And if you make the width of the first hole of the left skin half the width of the first hole of the right skin, then similarly you will make the ratios of the remaining holes of the left skin. And if you make the first hole of the left skin wider than the first hole of the right skin, then similarly you make the ratios of the remainder [of the holes]¹ of the left skin.

"The sense of this is that for these pipes D and K we posit fixed widths, just as we wish, either equal or unequal. Then we make the ratio of the pipe H to pipe D in proportion [as 2 is to 1, and likewise we make the ratio of pipe Y to pipe K. Then we make the ratio of pipe W to pipe D in proportion]² as 3 is to 1, and likewise we make the ratio of pipe Ṭ to pipe K. And we make the ratio of pipe Z to pipe D in proportion as 4 is to 1, and likewise we make the ratio of pipe Ḥ to pipe K. 'And this

¹⁹ Not in the Brit. Mus. MS. ²⁰ Not in Brit. Mus. MS.

¹ Not in the Brit. Mus. MS.

² Omitted in Brit. Mus. MS., but complete in the Constantinople MS.

The Organ of the Ancients.

is the ratio of the pipes which are called 'the passages of the wind.'³

"Then mount upon the mouth (? head) of the middle skin a pipe, its length 54 cm. (= 1 *dhirā'*), projecting by itself. And its width is the width of a *dirham*.⁴ Then fix it so that there is no vent-hole, and it is the pipe B-L.

"Then perforate in the chest of each skin four holes, and let the distance between the holes be exactly equal. And let these holes be in the size, and width, and measure, according to the size of the pipes [called] 'the passages of the wind,' and according to their ratios. Then mount upon these holes pipes of brass, of which the width and ratio are according to the size of the holes. And let the length of each pipe be 54 cm. (= 1 *dhirā'*). Then let these pipes be standing vertically, projecting from the chests of the skins. And they number twelve pipes. And those in the A skin on the right are marked M, N, S and X: and those in the B skin in the middle [are marked] F, S, Q, and R: and those in the J skin on the left [are marked] Sh, T, Th and Kh.

"Then mount with a firm arrangement upon every one of these pipes, at its extremity, a 'sound-box' (*sha'irat al-mizmār*),⁵ and you will get twelve sounds. Then, for these twelve vertical pipes in which are the 'sound-boxes' from which the sounds proceed, you insert (*ittakhadha*), in the middle of them, 'stoppers' (*bithūn*),⁶ firm and dry,

³ The word "passages" is corrupt in the Brit. Mus. MS.

⁴ A *dirham* was a silver coin equivalent to and about the same size as a sixpence.

⁵ Here, the "reed-box" is meant. See the *Mafātih al-'ulām*, 237, and Land's *Recherches*, 128.

⁶ The texts of the Brit. Mus. MS. and the *Mashriq* have *bathyūn*, or *bathnūn*, but the diagram in the latter has *bithūn*, which appears to be the correct form. It is the Greek *ἐπιτόμιον* = "stop-

The Organ (Pneumatic) from Arabic Sources.

which are shut and opened in order to change the sounds. And this is the chief requisite in the making [of this instrument]. So understand that.

"Then to return to the pipe which was in the chest (? head)⁷ of the [middle]⁸ skin, it is B-L, and it is the place of blowing and the entering of the wind. Then mount upon it a small skin, firmly fixed to the extreme end L, and it is the skin marked D [? Dh]. Then insert in this skin four pipes, the length of each pipe being 81 cm. (= 3 *shibr*), and the width of each pipe being of a convenient size for the lips [of the blowers].⁹ And the pipes are marked D, Z, Gh and S.

"Then place the whole of this instrument upon a framework (*sarir*), and prepare places for the seating of the men who blow. Then, if you wish to play sorrowful music (*lahn*), close all the 'stoppers' (*bithūn*) which are in the pipes, and do not press out from them any air,¹⁰ except [from] the hole of the second pipe of the second contrivance (? skin), the upper one of the first skin, and the hole which is in the fourth pipe of the second skin and it is opposite the upper pipe of the third skin, and it is half of the upper, which means that you close all the 'stoppers' except N, Z [sic], and T. Then when they blow, let their blowing be gentle, moderate in degree, for nobody is

cock, tap." The Banū Mūsā and the Arabic *Kitāb al-ḥiyāl* of Philōn have *bithūn*, whilst Badī' al-Zamān has *fithūn*, and the Apollonios and Archimedes treatises have both *bathnūn* and *bathyūn*.

⁷ Elsewhere called the "mouth." ⁸ Not in the *Mashriq* text.

⁹ The *Mashriq* text reads, "the width being according to what the 'sound-box' is joined to."

¹⁰ From here the bewildering text does not conform to the notation that follows. The Constantinople MS. does not help us to elucidate it because it is not so full and only gives the notation N and T. The *Mashriq* text is as vague as the British Museum MS.

The Organ of the Ancients.

able to hear this sound except that grief enters into him, and his temperament is quieted, and sleep so overcomes him that he sleeps where he stands.

"And if you wish that you should play music (*lahn*) which will conduce to wakefulness and courage, then blow the hole of the first pipe which is the upper one of the first skin [A], and the second hole of the second skin,¹¹ and it is an upper one also, and the third hole of the third skin,¹² which means that you open the 'stoppers' M, Ş and Th. Then the blowing will be with violence, for the sound has to produce what is conducive to courage and wakefulness.

"And if you wish to produce delight and activity in the temperament of man, until his senses are carried away, and he continues weeping and moaning, then blow the hole of the second upper pipes, and the third upper [pipes] of all the skins, which means that the 'stoppers' N, Ş and T and Sh (? S), Q, Th, are opened. Then regulate the sound,¹³ and let the blowing be with moderation. Then upon that there appears in man [the mediator of]¹⁴ joy and gladness, and depression of the intelligence. And he weeps without knowing why he weeps.¹⁵

"And if you wish to perplex the listeners until their souls become flaccid and the bodies weak, then open the holes of the upper pipes of the three skins and the holes of the pipes opposite the upper pipes, and they are the low [sounds], which means that the man opens the 'stoppers'

¹¹ Meaning, "the hole of the second pipe of the second skin."

¹² Meaning, "the hole of the third pipe of the third skin."

¹³ This phrase, by a copyist's error, comes before the notation, in the British Museum MS., but I have transposed it.

¹⁴ Not in the *Mashriq* text.

¹⁵ The *Mashriq* text differs somewhat from the British Museum MS. here.

The Organ (Pneumatic) from Arabic Sources.

M, F and Sh, the high [sounds] and the 'stoppers' X, D¹⁶ and Kh, the low [sounds]. Then you will see a marvel, because this 'compound' (*tarkīb*) is alien (lit. 'external') to the temperament of man, because a man does not comprehend upon hearing it what we have mentioned.

"And the ears of those who blow will be stopped in order that there may not affect them what affects the hearers, otherwise their work would be useless.

"And it will be more effective for the increase of the sound, and its strength and length and duration, that those who blow should be twelve according to the number of pipes. Then if you desire that, let there be inserted in the small skin, twelve pipes for twelve men.

"Then let those who blow be clever and experienced in the art concerning singing (*ghinā'*) and the scansion of melody (*lahn*), because it may be necessary for them to play melody (*lahn*) for the notes (*nagham*) of regular poetry, just as the player of the *mizmār al-wāḥid* which is called the *surṇāy* (reed-pipe) and the *nāy* (flute) makes melody (*lahn*). And let their larynxes (lit., 'the instrument of their throats') be wide and sounding.

"And we can only compare this instrument [the Comprehensive Reed-pipe Organ] to the disposition which is to be found in the composition of man. It [the organ] is one of the best composite productions (*mizāj*) among the instruments of sound, with its manifold means of use, sounding all the sounds that one desires, in all the languages of land and water animals. And no one will be able to construct these instruments, which are adapted to man, in such a way that the sound is produced as we have

¹⁶ The design has R, and Wiedemann says R.

The Organ of the Ancients.

mentioned, except in the manner in which this instrument has been described."¹⁷

This document describes a pneumatic organ of a type anterior to anything that we know of in Byzantium or Western Europe. It is certainly much earlier than the instrument depicted on the Obelisk of Theodosius (died 393),¹⁸ the fourth-fifth century Roman instrument,¹⁹ the Stuttgart codex (tenth century),²⁰ the descriptions of Bernelius (c. 990) or Pseudo-Bernelinus,¹ Notker Labeo (d. 1022),² Eberhard of Freisling (eleventh century),³ Theophilus (eleventh century),⁴ or the Pommersfelden codex (eleventh century).⁵

In both the British Museum and Constantinople MSS. the instrument is termed a "Reed-pipe Organ." This is borne out by the description of the instrument which specifies pipes of the *same length*. The diagrams in the various MSS. give us merely a "bird's eye view" of the instrument, which, save for the mere suggestion of a framework in the Bairūt MS. (see *frontispiece*), shows nothing in the nature of an organ case. The three skins or wind chests seem to have served, by reason of the weight of the pipes, as pressure-stabilising bellows at the same time.

The blast-bag (i.e., the "small skin" mentioned in the text), with its four insufflation pipes for the mouths of the

¹⁷ In the *Mashriq* text there is no clue for the elucidation of the notation in the design. (See *frontispiece*.) Further, parts of the text dealing with the *tarkibāt* (sing. *tarkīb*) have got badly mixed, which even the learned Père Cheikho was unable to rectify. Even the Constantinople MS., as translated by Professor Dr. Wiedemann, does not conform strictly to the British Museum MS.

¹⁸ See *ante* pp. 39, 46.

¹⁹ See *ante* pp. 46.

²⁰ Königl. öffentl. Bibl. Cod. bibl., folio 23.

¹ Gerbert, *Scriptores*, i, 318, 325. ² *Ibid*, i, 1000.

³ *Ibid*, ii, 279.

⁴ Theophilus, iii, 81-4.

⁵ Gräfl. Schönbornsche Bibl. Cod. 2776.

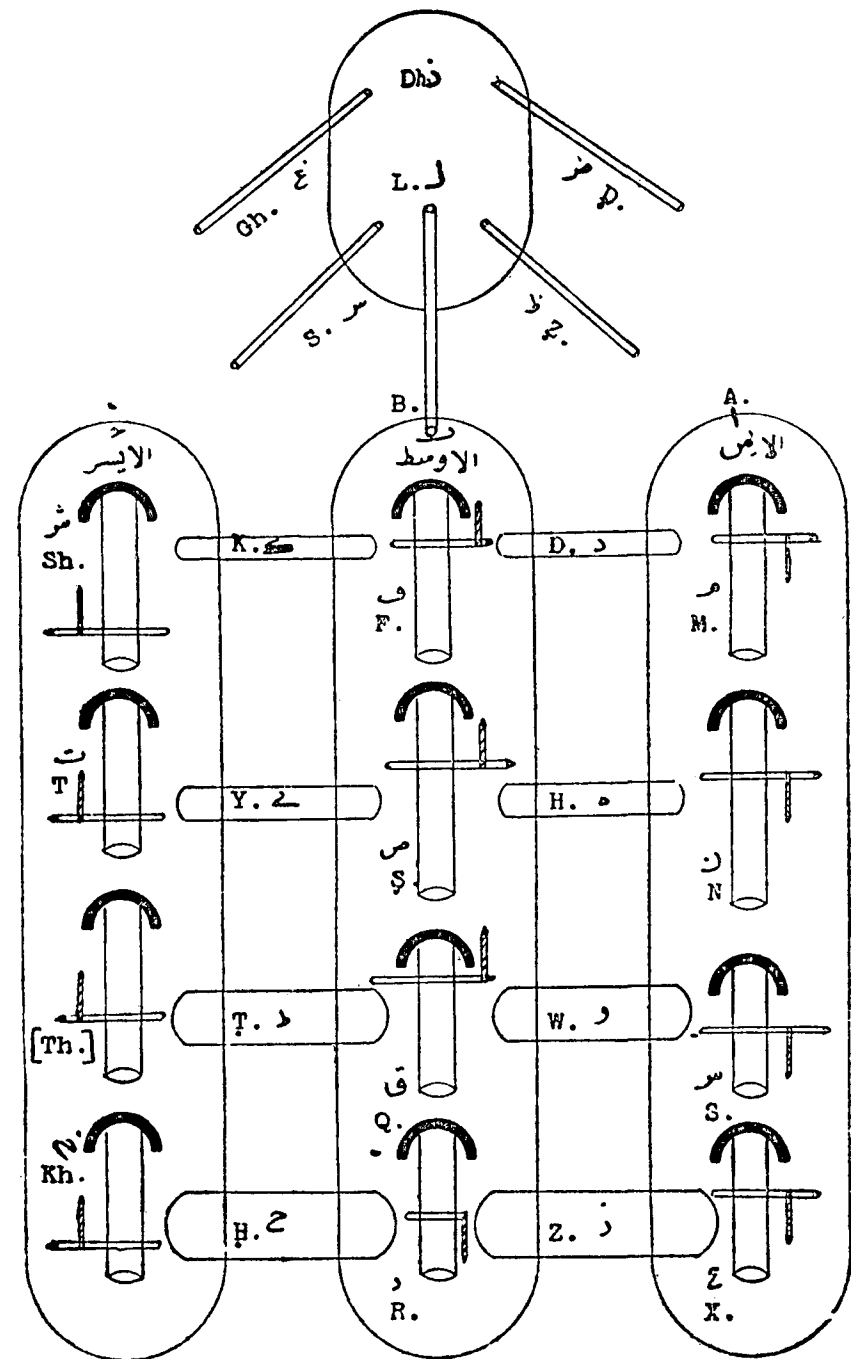


FIG. 1.—THE MORISTUS PNEUMATIC ORGAN.

(*Al-urghin al-zamri.*)

British Museum MS., Or. 9649.

The Organ of the Ancients.

blowers, is the only example that has come down to us from antiquity of this primitive method of organ blowing. Further, as has already been pointed out, it justifies the contention of other writers that in the earliest attempts the supply of wind was furnished by the mouth.⁶

There is no keyboard such as we know of by that name. In the Bairūt MS. (see *frontispiece*) the *bithānāt* (sing. *bithān*), or "stoppers" as I have called them, have the form of "sliders" not unlike the appliances delineated in European MSS. which contain designs of organs.⁷ In the Bairūt MS. these "sliders" are mentioned as being fixed in the *middle* of the pipes. In the British Museum and Constantinople MSS., these "stoppers" are given the form of a tap or stopcock, and they are shown inserted not in the middle, but in various places.

The question of the *tarkīb* or "compound" of notes produced by the Comprehensive Organ of Mūrīṣṭus is of considerable interest. When I wrote my *Historical Facts for the Arabian Musical Influence*,⁸ I only had the Bairūt Mūrīṣṭus as a guide.⁹ In this MS., as may be seen from the design, each "stopper" or pipe is marked with an Arabic letter (see *frontispiece*). This notation being similar to a musical notation given by a certain Arab theorist of music named Ibn Zaila (d. 1048), led me to say in the book mentioned above, that "if we may assume that these symbols [on the Mūrīṣṭus organ pipes] have the same pitch values" as the notation of Ibn Zaila, we could

⁶ *Encyclopaedia Britannica*, xx, 266.

⁷ For instance, the Cambridge MSS., St. John's College Library, B, 18, and Trinity College, B, X, 4. The designs of the Mūrīṣṭus pneumatic organ (*frontispiece* and Fig. 1) will be better appreciated if they are turned upside down.

⁸ Page 104.

⁹ See my *Studies in Oriental Musical Instruments*, p. 34.

The Organ (Pneumatic) from Arabic Sources.

find out what these *tarkībāt* were. On this assumption, purely tentative, I gave some examples of these *tarkībāt* or "compounds" of notes (i.e., chords). The recent acquisition by the British Museum of an exemplar of the Mūrīṣṭus treatise, and the fresh light thrown by the Constantinople MS., show that the suggestion cannot be insisted on. Of course, the scale assumed in these works may indeed be the one actually used. It is a lute scale. On the other hand it may have been built on a semitonic scale seeing that there were twelve pipes. At any rate, it is now quite clear that none of the MSS. give a definite clue to the actual notes given by the twelve pipes, other than that the lowest row of pipes (X, R, Kh) gave the low notes, and the highest row (M, F, Sh) the high notes.

It is a pity that the great Arabian musical theorists, Al-Kindi (d. c. 874) and Al-Fārābī (d. 950) did not deal with the organ in their treatises. The important *Kitāb al-mūsīqī al-kabīr* of the latter was compiled in Syria, a land which was evidently well acquainted with the organ, and a line on the organ from the master hand of its author, would have been an invaluable guide in this inquiry.

Ibn Sīnā (d. 1037), the famous successor of Al-Fārābī in the Arabic world of science and philosophy, has merely mentioned the organ *en passant* in his *Kitāb al-shifā'*. He says:

"And sometimes there are made instruments that are blown into, of composite structure, when we get the like of the Byzantine instrument known as the organ."¹⁰

In another work attributed to Ibn Sīnā, entitled *Rasā'il fi'l-hikma*, there is this passage:

"Among the appendages to the science of music, is the

¹⁰ India Office MS., No. 1811, fol. 173.

The Organ of the Ancients.

construction of marvellous, extraordinary instruments, such as the organ (*urghan*)¹¹ and what resembles it."

Ibn Sīnā's disciple, Al-Ḥusain ibn Zaila (d. 1048), was the author of a rare work named the *Kitāb al-kāfi fi'l-mūsīqī*, now in the British Museum. In this work there is a passage similar to that in the *Shifā*:

"And sometimes there are made instruments that are blown into, of composite structure, when we get the like of the organ (*urghanun*), and other than this."¹²

It will be noticed that nearly all these writers refer to the Byzantine or Greek organ. This does not mean that it was not used by the Arabs, but merely that it was of Byzantine or Greek origin. Arabic authors frequently name their instruments after their place of origin or provenance, just as we read in the *Alf laila wa laila* ("Thousand and One Nights") of the Damascus lute ('*ūd jilliqī*), the Persian harp (*jank 'ajamī*), the Tartar flute (*nāy tatarī*), the Egyptian psaltery (*qānūn miṣrī*).¹³

We know from the Mūristus documents and from Ibn Abī Uṣaibi'a, that the Arabs were not only interested in, but were actually constructing organs between the ninth and twelfth centuries.¹⁴ The manner in which the Ikhwān al-Ṣafā' (tenth century), include organs in a long list of indigenous musical instruments seems a point in favour of this view.¹⁵ Al-Ḥusain ibn Zaila (d. 1048), who

¹¹ *Rasā'il fi'l-hikma*, 77. The text has *urghal* instead of *urghan*. See Carra de Vaux, *Philon de Byzance*, 38, and Ronzevalle, 29.

¹² Brit. Mus. MS., Or. 2361, fol. 235v.

¹³ *Alf laila wa laila*, i, 372. See my *Studies in Oriental Musical Instruments*, pp. 10, 20.

¹⁴ Ibn Abī Uṣaibi'a, ii, 155, 163. See *ante* p. 16 *et seq.*

¹⁵ Ikhwān al-Ṣafā', i, 97. At the same time, two out of the twenty instruments mentioned, the *salbāq* (=σαμβούκη) and the *armūnīqī* certainly carry Greek names.

The Organ (Pneumatic) from Arabic Sources.

quotes Ibn Sīnā almost verbatim, dispenses with the qualification "Byzantine," which may have been deliberate.

How far the pneumatic organ was favoured by the Arabs is difficult to determine. Perhaps it was only taken kindly to in Syria, where we know that it continued in favour until the twelfth century at least, since Arab constructors are mentioned at this period. Two of these organ builders are signalised by Ibn Abī Uṣaibi'a (d. 1270) in his '*Uyūn al-anbā*, and they are Abū'l-Majd Muḥammad ibn Abī'l-Ḥakam and Abū Zakariyyā Yahyā al-Bayāsī. Abū'l-Majd (d. 1180) was a physician, scientist and musician, who was in the service of the Zangid *atābag* Nūr al-Dīn (1146-74) at Damascus. His biographer says:

"Abu'l-Majd had knowledge of the science of music (*mūsīqī*) and played the lute ('*ūd*); excelled in the song (*ghinā*'), the rhythms (*iqā'*[*āt*]), the reed-pipe (*zamr*), and other instruments. And he constructed an organ (*urghan*) in which he attained perfection."¹⁶

Abū Zakariyyā was an Andalusian Arab by birth, but he spent most of his life in Egypt and Syria in the service of the Ayyūbid sultān Salāḥ al-Dīn (1169-93), otherwise known as Saladin. He too was both a musician and scientist. Of him it is said:

"Abū Zakariyyā . . . made for Ibn al-Naqqāsh many instruments of a composite nature, which he derived from engineering (*handasa*), . . . was an excellent player on the lute ('*ūd*), and he constructed an organ (*urghan*), and sought by artful contrivance the playing of it."¹⁷

When Baghdād was captured in 1258 by the Mughal hordes of Hülāgū, the Khalifate proper came to an end,

¹⁶ Ibn Abī Uṣaibi'a, ii, 155. ¹⁷ Ibn Abī Uṣaibi'a, ii, 163.

The Organ of the Ancients.

and with it much of what counted for culture in the Near East. It was due to the Mughals however that the organ was introduced into China. We have the event and the instrument described in a Chinese document, the *Yüan shih*, where the organ is called the *hsing lung shêng*. We are told that this organ was "presented by the Muslim kingdoms in Chung-t'ung (1260-64)" In another work, the *Wang chung wên kung chi*, we have the information that the instrument was "an offering from the lands of the West," and that the Emperor Khubilâi himself "added improvements to it." We may suppose that this organ actually came as a present from Hülâgû to Khubilâi, who was his kinsman, and probably it was made in Syria.¹⁸

After this, the organ passed out of use in Muslim lands, and was only recognised as an "instrument of the Europeans." In Persia, however, the organ appears to have had some vogue even up to the time of Ḥāfiẓ the poet (d. 1389), since the organ (*urghanun*) is enumerated among the instruments of music in use in his *Mughannî nâma*.¹⁹

The famous Perso-Arab musical theorist, 'Abd al-Qādir ibn Ghaibî (d. 1435), whose holograph MS. of the *Kitāb jāmi'* *al-alḥān* is preserved in the Bodleian Library says:²⁰

¹⁸ See the Rev. A. C. Moule's articles on this instrument in the *Journal of the China branch of the Royal Asiatic Society* (1908), the *Journal of the Royal Asiatic Society* (1926) and the additional article by the Rev. Canon F. W. Galpin in the same journal, as well as the present writer's *Studies in Oriental Musical Instruments*, p. 30.

¹⁹ Ḥāfiẓ, *Diwān* (Edit. Jarrett); 225. It is, however, highly probable that the organ was used by the Arabs of Spain. It is certainly not mentioned in the *Kitāb al-imtā' wa'l-intifā'*, but see later, p. 158; Ribera, *Enseñanza entre los musulmanes*, p. 97, and my *Studies in Oriental Musical Instruments*, pp. 20-23.

²⁰ Bodleian MS., No. 1842, fol. 78.

The Organ (Pneumatic) from Arabic Sources.

"The organ (*urghanun*) is much used by Europeans. It is constructed of pipes arranged in a row. Behind them are arranged bellows from which the wind goes into the pipes. . . . And with the left hand they move the bellows, and with the fingers of the right hand they play. And the notes are in its pipes, and to every pipe there is a 'pallet' (*lit.* 'screen') in the form of a . . . (?) . . . which, when pressed down, opens a passage (into the pipe) and its voice is heard."

The mention of the bellows being worked by the left hand, and the *pallets* by the right hand, shows that the writer had a small portative organ in mind.

In the sixteenth century, the organ was still a "foreign" instrument to the Persians, since it is mentioned in the *Burhān-i qāṭi'*, thus:

"The organ (*urghanun*) is that instrument which the Europeans (*Rāmiyān*) play."

The last references to the organ that are of interest are those by Tāshkopri-Zāde (d. 1560),¹ Ḥājji Khalifa (d. 1658)² and Evliyā Chelebî (d. c. 1679). Tāshkopri-Zāde refers to the organ in such a way that it is quite clear that the instrument was alien to the Turks in his day. He says:

"I saw and heard the organ frequently, but the sight and impression only increased my awe and my confusion."

Ḥājji Khalifa, however, writes about the instrument not from personal experience, but after consulting an older authority, probably Al-Khwārizmî (tenth century), and practically in the same words. He says:

"After him (Pythagoras), other wise philosophers added to what he had invented, until the turn came to Aristotle, and he conceived and constructed the organ, and it is an

¹ *Miftāh al-sa'adat*.

² Ḥājji Khalifa, i, 399, vi, 258.

The Organ of the Ancients.

instrument of the Greeks (Yūnāniyyūn), made of three large bags of buffalo skins, one being joined to the other. And there is mounted upon the head of the middle bag another large bag. Then there are mounted upon these bags, pipes having holes upon recognised ratios, from which proceed beautiful sounds, fine and pleasant, according to the wish of him who uses them."^{2a} These are all Turkish writers, but the first two wrote in Arabic. The famous English organ builder, Thomas Dallam, constructed a mechanical clock-organ for the Sultan of Turkey in 1599-1600, and installed the instrument personally.³ The mention of the European organ by Evliyā Chelebi, in his chatty *Siyāhat nāma*, deserves to be reproduced here:

"The organ (*urghanun*) . . . is generally found in the country of the Franks. There you will find in every convent and church, a large organ with three hundred pipes, with two pairs of bellows, each moved by ten monks, and touched with the fingers. And when it begins to sound in a mournful tune like that called *rahāwī*, the monks sing to it the verses of the psalter. They are in the habit of castrating boys in order to preserve their voices. These boys are made to stand on the upper part of the bellows, with which they rise and descend, singing the verses of the psalter to a mournful tune, *rahāwī*, so that the hearers are all enraptured. . . . This tune is so called from the town of Raha (Edessa), where David invented this instrument, which absolutely must be heard to have an adequate idea of it."⁴

^{2a} See *ante*, p. 59-60.

³ *English Historical Review*, v, 656. A full account of it is given in a MS. in the British Museum.

⁴ Evliya Efendi, *Travels*, i, ii, 226.

CHAPTER VI.

THE ORGAN FROM ARABIC SOURCES.

(HYDRAULIC ORGANS.)

"The power then passed to the Greeks (*Rūm*). It is to these people that the savants belong who have dealt with astronomy, geometry, medicine, arithmetic, music, magic glasses, talismans, pneumatic and hydraulic machines, and all the sciences."—*Mukhtaṣṣar al-'ajā'ib* (tenth cent. ?).

FROM such works as the Arabic versions of Pseudo-Aristotle's *Kitāb al-siyāsa* (*Secretum secretorum*), Philōn's *Pneumatics* and Herōn's *Pneumatics*, it is evident that from the late eighth and early ninth century the Arabs were conversant with several devices for the production of sound by means of hydraulic action, whilst the treatises on the *klepsydra* and the *Automatic Wind Instrumentalist* attributed to Archimedes and Apollonios of Perga, reveal that they were acquainted with types of *hydraulic air compressors* connected with flue and reed pipes. These instruments, as well as an automatic wind instrument designed by the Banū Mūsā in the ninth century, have been included in this chapter under the label of *hydraulic organs*, so as to distinguish them from the *hydraulis* which is a *hydraulic pressure stabiliser*.

The simplest examples of pipes being made to speak by means of hydraulic pressure are the whistling instruments

The Organ of the Ancients.

mentioned in the *Pneumatics* of Philōn,¹ and the *Pneumatics* of Herōn already mentioned.² The musical tree that was erected in the palace of Khalif Al-Muqtadir (908-32) was constructed on these principles,³ and the design for such a tree may be seen in a MS. in the British Museum.⁴ More elaborate were some of the instruments attributed to Archimedes (Arshimīdis) and Apollonios (Ablūniyus). These were worked much in the same way as their *klepsydras*, which were known to the Arabs as early as Khalif Hārūn al-Rashīd (786-809) who presented one to the Emperor Charlemagne in 807.⁵ A somewhat similar appliance was installed in the mosque of the Banū Umayya at Damascus.⁶ One type of *klepsydra* announced the hours of the day, not by a *cymbalum* as in the Charlemagne instrument, but by a flue pipe.⁷

In a treatise attributed to Archimedes on the *Automatic Wind Instrumentalist* (*ālat al-zāmīr*), we have the figure of a wind instrumentalist holding a flute (*nāy*) or reed pipe (*zamr*) which is made to sound by air being forced through it by the fall of water into a cistern (Fig. 2).

The Apollonios instrument, as set down in the *Ṣan'at al-zāmīr* (Construction of the Wind Instrumentalist),⁸ is

¹ See Carra de Vaux, *Philon de Byzance*, for a complete Arabic text and French translation of the *Pneumatics*.

² Schmidt and Nix have made a German translation of the *Pneumatics* from the Greek and the *Mechanics* from the Greek and Arabic.

³ *Journal, Royal Asiatic Society* (1897), 40, 42.

⁴ Brit. Mus. MS., Or. Add., 23391, fol. 19.

⁵ *Mon. Germ. Hist.*, i, 194. ⁶ Ibn Baṭṭūṭa, i, 209.

⁷ See *ante* p. 14.

⁸ This is the title in the Brit. Mus. MS. The Bairūt MS. is entitled '*Amal ālat al-zamr*' ("The Making of the Wind Instrument"). There is no particular reason for supposing that these

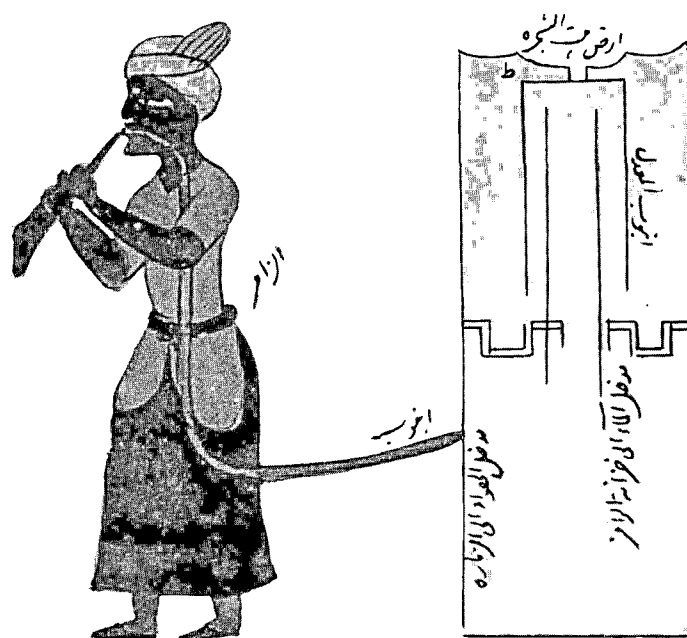


PLATE 1. THE ARCHIMEDES AUTOMATIC WIND INSTRUMENTALIST.
British Museum MS., Or. Add. 23391.

The Organ (Hydraulic) from Arabic Sources.

quite an elaborate affair. It is made of three compensating cisterns, one on top of the other, the bottom one having two divisions. The top cistern (*khazānat al-mā'*) A,⁹ supplied the water, which flowed from it through a channel (*mīzāb*) B, on to a water wheel (*dālāb*) C, emptying itself into the cistern X. On the axis of the water wheel there was a cogwheel (*dā'ira*) D, which interlocked with

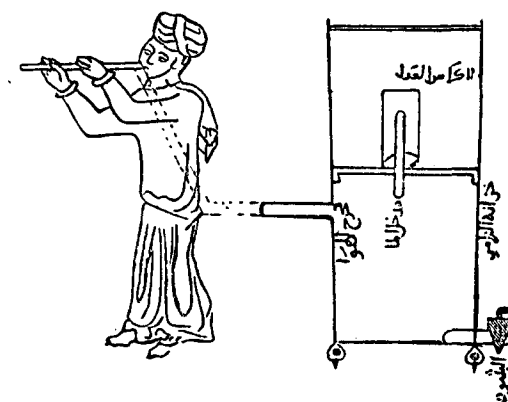


FIG. 2.—THE ARCHIMEDES AUTOMATIC WIND-INSTRUMENTALIST.

another cogwheel which worked on a vertical axis (*'amūd*), E, at the bottom of which there was a disc (*nuṣf dā'ira*) F, with a portion of it cut out, G. This disc, in

works "attributed" to Archimedes and Apollonios are not genuine. We certainly do not possess Greek originals, but we have several works by these authors that have survived in Arabic only, viz., three books of the *Conics* and the *Sectio Rationis* of Apollonios, and the *Liber Assumptorum* of Archimedes (?).

⁹ The Roman letters that I have added to the designs so as to elucidate the text do not correspond with the Arabic notation.

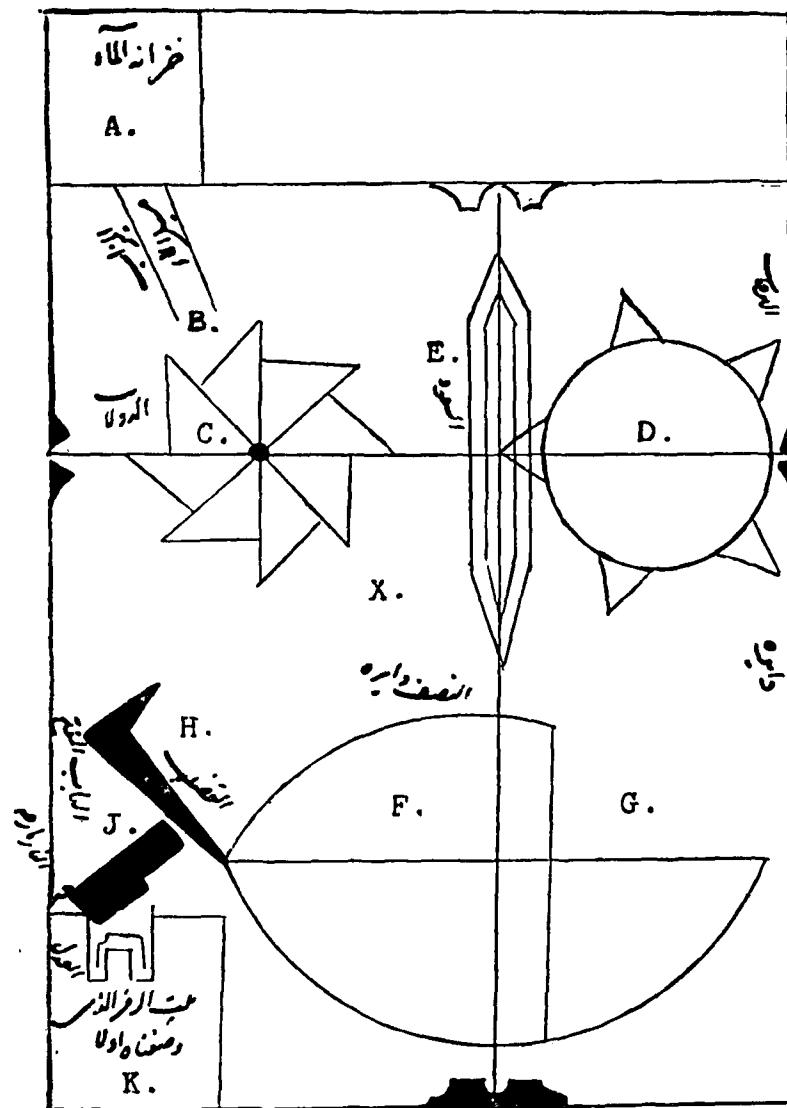


FIG. 3.—THE APOLLONIOS AUTOMATIC HYDRAULIC ORGAN.

Showing the mechanism of the water-wheel cistern (X).
British Museum MS., Or. Add. 23391.

The Organ (Hydraulic) from Arabic Sources.

rotating, lifted alternately, two rods (*qaḍīb*) H, which opened and closed alternately two valves (*bāb*) J, in the bottom of the cistern X.

Above is the Arab artist's design of the mechanism of the two upper cisterns (Fig. 3).

This design is not drawn to scale, nor is it even in perspective, but reference to the complete design of the in-

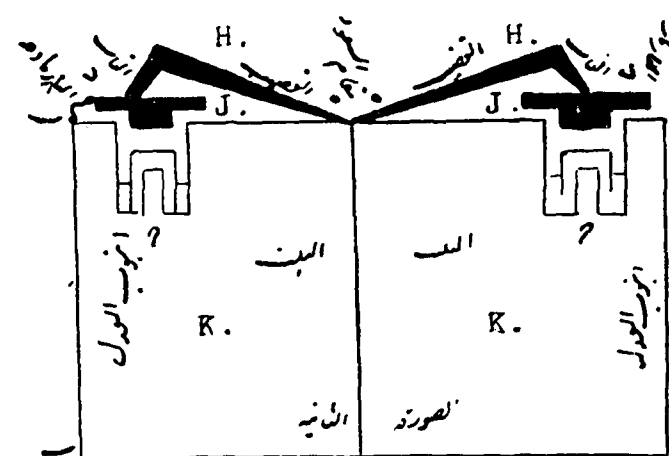


FIG. 4.—THE APOLLONIOS AUTOMATIC HYDRAULIC ORGAN.

Showing the two valves (J) through which the water passes from the water-wheel cistern (X) to the two air compressing cisterns (K).

British Museum MS., Or. Add. 23391.

strument based on a reconstruction made by Wiedermann, will serve as a corrective. See Fig. 7. It will be noticed that one of the two divisions of the lowest cistern K, has been squeezed into the left-hand corner of Fig. 3 so as to show how the disc F lifted the rod H and the valve J. A better idea of these rods and valves is given by the artist in Fig. 4.

The Organ of the Ancients.

In each of the two divisions of the bottom cistern K, there was a lever working on a fulcrum M, one end having a cup N, and the other end having a counterweight (*rum-māna*) O. This lever moved up and down according to whichever end had the preponderance. When the water poured through the valve J into one of the divisions K, it fell into the cup N, which, when filled, had the preponderance, and descended. It closed the valve P at the

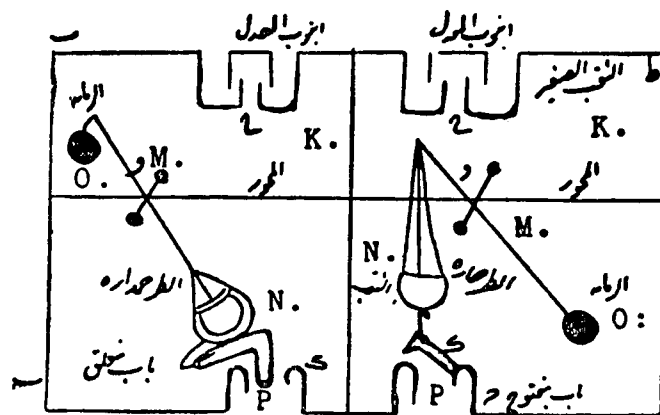


FIG. 5.—THE APOLLONIOS AUTOMATIC HYDRAULIC ORGAN.

Showing the two air compressing cisterns (K), shut and open.
British Museum MS., Or. Add. 23391.

bottom of the division in its descent, through which air had passed previously into the division. Here is the artist's design of the bottom cistern K with its two divisions.

The water gradually accumulated in the division, and, as it rose, the air that was already in this division was driven out through a wind-pipe (*unbūb al-rīḥ*) Q, equipped with a non-return valve (*bāb midfa'*) R, into a

The Organ (Hydraulic) from Arabic Sources.

wind-chest (the *rukba* of the Banū Mūsā) S, and from there it passed into a sound-box (*ḥabba*) T, eventually sounding the flue-pipe (*nāy*).

Fig. 7 shows the composite instrument reconstructed.

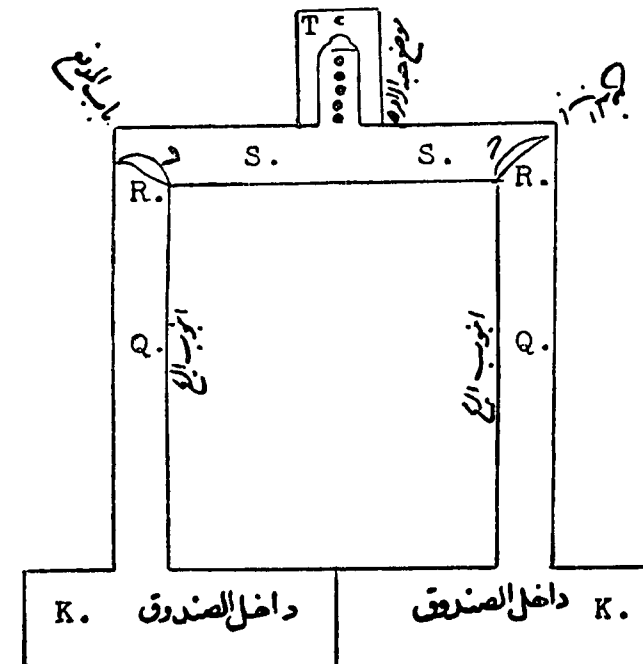


FIG. 6.—THE APOLLONIOS AUTOMATIC HYDRAULIC ORGAN.

Showing the wind-pipes (Q) which convey the wind from the air compressing cisterns (K), through the valves (R) to the transverse wind-chest (S).

British Museum MS., Or. Add. 23391.

The principle of Apollonios was borrowed and improved by the Arabs, as we know from the elaborate treatise written by the Banū Mūsā (ninth century) entitled *The Instrument which Plays by Itself* (*Al-ālat illatī*

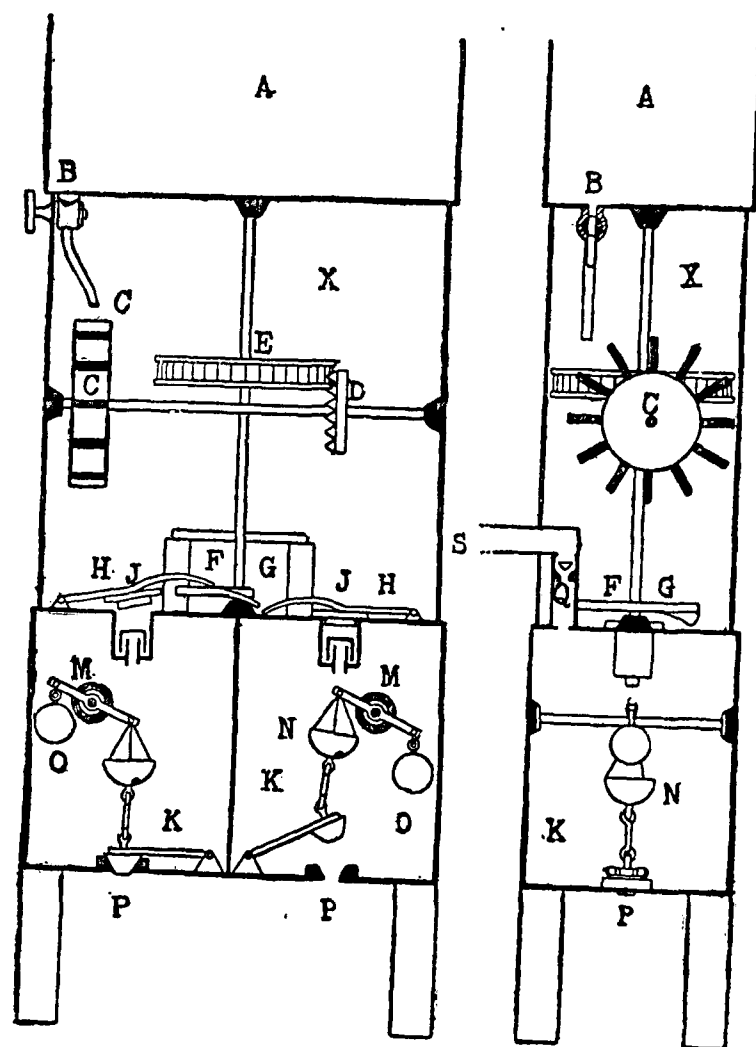


FIG. 7.—THE APOLLONIOS AUTOMATIC HYDRAULIC ORGAN. (Reconstructed.)

Showing the three cisterns.

The Organ (Hydraulic) from Arabic Sources.

tuzammir binafsihā). The three "Sons of Mūsā" (Banū Mūsā) were named Muḥammad (d. 873), Aḥmad, and Al-Ḥasan. They were probably the most celebrated Arab scientists of their day. Khalif Al-Ma'mūn (813-33), the great patron of learning, gave them positions at the *Bait al-ḥikma* ("House of Wisdom"), the College of Science at Baghdad, together with Yaḥyā ibn Abī Manṣūr (d. 831) and other scientists. They "attracted translators from other countries," and many Greek treatises were translated there which "revealed the marvels of science" to the Eastern world, and later to the West.¹⁰

The author of the *Fihrist* (d. 995-6) says that the favourite sciences of the Banū Mūsā were geometry, mechanics, music, and astronomy.¹¹ Ibn Khallikān (d. 1284) also assures us that music and mechanics were among their accomplishments.¹² Yet not a solitary work on music is mentioned under their names in the *Fihrist* nor by Ibn al-Qiftī, unless the *Kitāb al-urghanun* (*Book of the Organ*) mentioned in another part of the *Fihrist* may be counted as theirs.¹³ Aḥmad, we know, was the author of the *Kitāb al-ḥiyāl* (*Book of Mechanics*). The treatise on *The Instrument which Plays by Itself* that has come down to us under the name of the Banū Mūsā may possibly have come from the hand of Aḥmad.

This treatise, which is to be found in the library of the Three Moons College of the Orthodox Greek Church at Bairūt, Syria, appears to be a solitary exemplar. The copy dates from the twelfth century, and the Arabic text

¹⁰ *Fihrist*, 43.

¹¹ *Ibid.*

¹² Ibn Khallikān, ii, 315.

¹³ *Fihrist*, 285. Collangettes (*Etude sur la musique arabe*, 382) mentions a work on music by the Banū Mūsā. The authority was probably Casiri (i, 418). It is erroneous. What the latter translates as a *Liber de musica* is, in the text, a *Kitāb al-qarastān*. See my *Hist. of Arab. Music*, 128.

The Organ of the Ancients.

has been printed in the *Mashriq* with an introduction and explanatory notes by the late Reverend Professor Maurice Collangettes.¹⁴ The work is of such great interest, that a complete translation is given here. Throughout the treatise, references are made to diagrams which would explain the figures (alphabetical) used. Unfortunately, not a solitary diagram has been preserved in the Bairūt MS., and even the figures mentioned are not always correct.¹⁵

"THE INSTRUMENT WHICH PLAYS BY ITSELF."

"We wish to explain how an instrument (*āla*) is made which plays by itself continuously in whatever melody (*lahn*) we wish, sometimes in a slow rhythm (*iqā' thaqīl*) and sometimes in a quick rhythm (*iqā' khaṭīf*), and also that we may change from melody to melody when we so desire. And because the perpetual organ (*zamr*) is only played by means of a perpetual wind, we will first begin to explain how an instrument is made from which a perpetual wind supply arises.

"We make a vessel (*inā'*) of this kind. Its length 108 cm. (= 2 *dhirā'*), by a breadth of 108 cm., by a height of 108 cm., and we mark upon it A B J D.¹⁶ And we divide it into two halves by the surface (*saṭḥ*), H Z and K L. In one of the two divisions (*qism*), in this case it is the division A J Z H, there is a cup (*ḥauḍ*) Ḥ Ṭ, mounted upon the line (*saṭr*) Ṭ Y, working upon the axis

¹⁴ *Mashriq*, ix, 444-58.

¹⁵ I have endeavoured to correct these in brackets.

¹⁶ In all the figures given in this treatise, the recognised equivalents are used with the exception of the 'ain, for which X is substituted.

The Organ (Hydraulic) from Arabic Sources.

(*mihwar*) K. And at the end Y of the lever (*masṭara*) there is a weight (*thiqal*). The cup Ḥ Ṭ ascends to the top of the division if this cup is empty, and whenever it is filled with water it descends from the top of the division, and the weight which is upon the end Y ascends from the lever Ṭ Y. Then it moves the cup Ḥ Ṭ upwards and downwards upon the axis K, opening and closing, on the bottom of this division, a valve (*bāb maḥḥūn*) upon which is K [? L]. Its diameter will be 13.50 cm. (= 6 *isba'*). And that is because we join the cup Ḥ Ṭ to the valve K [? L] by means of a chain or rod, so that when the cup Ḥ Ṭ ascends, the valve L, which is in the bottom of this division, is opened, and when this cup descends the valve is closed so that nothing passes through it.

"Next, there goes out from the cover of the division, we mean the surface H [? J] Z, a pipe upon which is M N, its diameter being 2.25 cm. (= 1 *isba'*). And the making of the part of its end will be firm so that no air goes out from it when the valve K [? L] is shut, either to the outside of it or to the division upon which is H Z D B. And the making of the division upon which is H Z D B will be firm.

"Then it is clear that when the water is poured continually into the cup Ḥ Ṭ, the cup will descend, and in its descent it will shut the valve K [? L]. Then it will overflow, and it [the water] will accumulate in this division A J Z H gradually. Then as for the air which is in it [the division], there is no outlet for it anywhere except by the pipe M N. On that account, it [the air] will be continually going out from this pipe with the continual descent of the water into the division A J Z H. And because the supply (*madda*) of the air is cut off on the filling of the division A J Z H with water, then for that

The Organ of the Ancients.

reason there is need of the division H Z D B, which is similar to it. And in it also are some of the devices (*ala*) which we have described, and will describe in what follows, like those which are in the division A J Z H, in order that the two of them may be compensative until, when the exit of the air from the pipe M N is cut off on the filling the division A J Z H with water, the air goes out continuously from the pipe S X, which is mounted upon the surface Z D, which is the cover of the division upon which is H Z D B. So, as long as the water continues pouring into the division H Z D B, then the air goes out into the pipe S X.

"And we shall describe the arrangement in which there is the cutting off of the water from the division which is filled first, and comes to the last empty division. When the water is cut off from one of the two divisions, and in this case it is the division A J Z H, the cup H T empties itself from a small hole in the bottom of it at T. Then, when the water empties from it, the weight which is at K [? Y] descends, and the cup H T ascends, and draws the valve [L] and opens it. Then the water which is in the division A J Z H goes out from the valve Y [? L] until none of it remains.

"And the air is compelled to succeed the water which goes out from A J Z H, and it has no way to enter into it except by the valve K [? L]. Yet since water goes out sometimes and goes in sometimes (just as happens to vessels which are narrow of mouth, when we turn them upside down in order that the water may be emptied from them), it occasionally happens in this state that the exit of the water from the division A J Z H is retarded. And there is no way to make the air enter into this division from the pipe M N, because it is imperative that the air should not

The Organ (Hydraulic) from Arabic Sources.

return through the pipe M N into the division A J Z H. For that reason we make a thin pipe mounted on the surface J Z, upon which is F S, its end, upon which is F (and it is the upper end) is fixed to the surface J Z, and the end S, which is the lower end, is in contact with the bottom of the cup H T, which was empty. Then the supply (*mādda*) of the air comes to this division on the going out of the water from it.

"And we also make another pipe, like the pipe F S, mounted on the surface Z D of the division H Z D B, like what we have described of the structure of the pipe F S, in order that it may act when the water goes out from the division H Z D B by its valve which is in the bottom of it, and it is like the valve K [? L] [in the division A J Z H]. Then if we explain that the water does not cease flowing into one or other of the two divisions continually, according to the arrangement which we said we would describe, it is necessary that it [the water] should go out, and the air also, from the division into which the water pours through one of the two pipes M N and S X.¹⁷ And it is not possible that it should return by the other one of the two divisions on account of what we will describe also.

"But the air comes to a place sharing the two ends M [? N] X of the two pipes M N and S X, and it is the *kurra* (sphere) N X Q, and this also has a neck (*'unq*) upon which is Q, which enters into a specific junction (*rukba ma'mūla*) upon which is R S [? Sh] T, as we have drawn, fixed symmetrically in it by a paste (*lajan*)¹⁸ or glue (*lizāq*). And only the end of the 'organ-pipe'

¹⁷ There is something wrong with the text here. The water could not have entered by these pipes, which merely carried the air to the *kurra*.

¹⁸ The text has *laḥan*, but *lajan* is evidently intended.

The Organ of the Ancients.

(*surṇāy*) upon which is B [? Th] and in which is the 'sound-box' (*ḥabbat al-muṣawwita*), is entering into the junction R S [? Sh] T, arranged in it, as we have drawn, in order that the air may collect and be compressed continually in the *kurra* N X Q, and in the junction R S [? Sh] T, and there will not be an outlet to it except from the head of the sounding-reed upon which is B [? Th]. And for that reason the sound becomes continuous, not intermittent.

"And as for the reason why the air does not return by either of the two pipes M N and S X into the two divisions A J Z H and H Z D B, then that is because of our fixing two small valves, which are mounted upon the two ends Z [? N] X of the two pipes M N and S X, in order that their opening shall be in the interior of the *kurra* N X Q. The result is that when the air goes out from the two divisions [? division] A J Z H by the pipe M N into the *kurra* N X Q, the valve which is at the end N is opened by the air forcing it, and the other valve which is at the end X is closed because the air forces it also and shuts it, so that none of it [the air] returns by the pipe X S into the division H Z D B. And similarly, it happens to both [valves?] when the air goes out from the division H Z D B by the pipe S X into the *kurra* N X Q. Then it is clear that the water, if it were continually flowing into one of the two divisions, the air would be continually going out from the 'sound-box' upon which is B [? Th], so that there would result from this a continuous sound in the 'organ-pipe' (*surṇāy*) upon which is L [? Th] H [? Kh].

"And it is only the arrangement which is in it that makes the water which is in it, continually flowing, at one time into the division A J Z H, and at another time into

The Organ (Hydraulic) from Arabic Sources.

the division H Z D B, and it [the arrangement] is what we shall describe.

"We make a large cistern (*ḥaud*), its length 108 cm. (= 2 *dhirā'*) by a breadth of 67.5 cm. (= $1\frac{1}{4}$ *dhirā'*), by a height of 27 cm. (= $\frac{1}{2}$ *dhirā'*). And upon it Ṣ Ṭ X [? Ḍ Z Gh.] It has four legs, the length of each being 18 cm. (= $\frac{1}{3}$ *dhirā'*) mounted on the surface J R [? Z] D of the vessel (*inā'*) A B J D. And we may dispense with that when we wish. And we set up beside one of its two heads (and it is the one upon which is Ḥ Ṣ) a wide pipe, its diameter 5.625 cm. (= $2\frac{1}{2}$ *iṣba'*). Then its lower end is fixed to the bottom of this large cistern and is projecting from it to the outside of the bottom about 4.5 cm. (= 2 *iṣba'*). Then it stands up to nearly two-thirds the height of the cistern in its inside. Then it is bent until its end comes near one-third of the height of the cistern. Upon it is A B J. And we mount upon its end, upon which is Ḥ , a valve, its diameter 5.625 cm. (= $2\frac{1}{2}$ *iṣba'*), and we fix upon the male plug (*dhakar*) of it, a rod, so that it works freely, the male plug being covered by the female (*unthā*).

"And we make also, a large tap (*bithūn*), for the passage of the water, its diameter, 5.25 cm. (= $2\frac{1}{2}$ *iṣba'*), and upon it is A D. And its end upon which is A, is mounted in the inside of the end A of the pipe A B J, and the end D penetrates the surface J R [? Z] and comes near to the bottom of the cup Ḥ Ṭ which is in the division A J Z H, but fixed to the surface J Z with a firm sure fixing.

"And we make also a small cup of the height of 9 cm. (= 4 *iṣba'*). Upon it is D, and it comprises the end D of the tap (*bithūn*) A D. And let its width be according to what would break the strength of the water which empties into it from the tap A D, in order that the air may be able to go out by the tap D A. At the bottom of it is also a

The Organ of the Ancients.

nail (*mizmār*). When the cup [Ḥ Ṭ] [in division A J Z H] begins to empty, the nail enters into the hole Ṭ of the cup Ḥ Ṭ, in order that the hole Ṭ may not be blocked by any foreign matter (*ashyā'*) that may be in the water.

"So when this small cup is full, it overflows quickly. Then the cup Ḥ Ṭ [which is underneath it] fills and descends, and the valve K [ʔ L] is closed. And the cup Ḥ Ṭ also overflows and the water collects in the division A J Z H, and the air goes out from it by the pipe M N until it comes to the 'organ-pipe' (*mizmār*) upon which is Th, as we have explained.¹⁹ Then the sound is produced also.

"Then as for the pipe F Ṣ, which is in the cup Ḥ Ṭ, the water flows from it into the outside of the division because the end Ṣ is immersed in the water which is in the cup Ḥ Ṭ, and for that reason the air does not go out from it. And it has been in our power to make it only when required in emptying the division, and none of it [the air] goes out otherwise. But we have left it in this state, on account of its usefulness in making the air uniform which goes out by the 'organ-pipe' (*mizmār*), because the air, when it is strong against the 'organ pipe' to an intense degree, it possibly shuts it, and no sound arises from it. But when the pipe F Ṣ is open, the water goes out by it from the cup Ḥ Ṭ, flowing with considerable egress into the outside of the division. So it breaks the strength of the air on account of that, until it is strong enough to wind (*aṭbāq*) the 'sound box' (*ḥabba*) of the 'organ-pipe' (*mizmār*).

"And similarly, we make in the head T X of the [large]

¹⁹ Here the author changes his nomenclature, and speaks of the *mizmār* instead of the *surnāy*.

The Organ (Hydraulic) from Arabic Sources.

cistern D Ṣ Ṭ X and the division H Z D B, a thing like what we have made in the other head, I mean, like the small cup H [ʔ] D A [ʔ], and the tap (*bithān*) D A, and the bent pipe A B J [which is attached to it], and the valve J [ʔ Ḥ] which is mounted on the end Ḥ [ʔ J] of the bent pipe A Ḥ J.

"Then we make a half-disc (*nuṣf ḥalqa*) the breadth of which is 4.5 cm. (= 2 *isba'*), and its thickness a uniform one, but its diameter according to what is between the valve Ḥ and its like, upon which is Z Ḥ Ṭ, and upon its diameter R B Q. And the centre of its circle is Y, and it is parallel to the bottom of the cistern, and nearly touching the valve Ḥ, and its parallel also is the horizon. And it [the half-disc] turns round under these two valves, upon a [vertical] pillar (*amūd*) K Y L, and let the mounting of this pillar in the straight side (*qitr*) be firm.

"Then when this half-disc turns round under one of the two valves, the rod which is upon the male plug of the valve rises up, and the valve is opened, and the water which is in the cistern D Ṣ Ṭ X enters through this opened valve, because we always make this cistern full of water. Then it flows through the large bent pipe, and through the large tap (*bithān*), until it comes to the division upon which it is mounted. And the other like valve will be closed [and] no water will enter through it, nor does the water cease going down into that division until it [the rod] reaches the end of the arc (*qaus*), and the straight side upon which is Ṭ, as far as the male plug (*dhakar*) of the valve A B J, then it lifts (*lit.* 'pushes') it, and the valve J is opened, until the water flows into the division A J Z H. And in order that the supply of the air may be cut off from the 'organ-pipe' (*mizmār*) at any time, it is necessary that the valve (which is like the valve J) should not

The Organ of the Ancients.

be shut, but that the two will be open until the water collects in the division A J Z H, and the water [? air] goes out from the two pipes M N and N X together into the 'organ-pipe' (*mizmār*). Then when the air which goes out through the pipe M N, is strong upon that, the end of the arc (*qaus*) and the straight side (*qitr*) upon which is Z, [and] the rod which adheres to the male plug (*dhakar*) of the like valve, separate. Then, upon that, it [the valve] is closed, and the water is cut off from the division H Z D B, and by that the water is emptied from the division H Z D B, as we have explained before in regard to the division A J Z H. So it will be clear from what we have described, that if the turning of the half-disc be continuous, then the water comes constantly into one of the two divisions for a long time, or in both of them for a short time. Then for that reason, the going out of the air by one of the two pipes M N and S X, or by both of them for a short time, is not cut off, and it reaches the 'organ-pipe' (*mizmār*) so long as the large cistern is full of water, and the half-disc turns round under the two valves.

"Next, we make the ends of this [vertical] pillar ('*amūd*'), fixing that end which is in the straight side of the half-disc upon which is K (and it is the lower end), goes round in a hole in a block (*libna*) mounted on the bottom of the large cistern, and the other end is that which goes round in the cross-beam upon the end of which is M N. And these two ends are mounted upon the two ends of the two columns (*ustuwān*)²⁰ mounted upon the end of the large cistern upon which are M S [and] N X. Next, we make a little wheel (*dā'ira*) furnished with cogs

²⁰ A Persian word, perhaps from the Greek *στροά*.

The Organ (Hydraulic) from Arabic Sources.

(*dandānja*),¹ and a compartment (*bait*), in the midst of which is a pillar ('*amūd*') K Y L, with angles (*sāwiya*)² as we have drawn them, in order that it [the little wheel] may go round with the turning of the pillar K Y L.

"And we make also, another strong pillar ('*amūd*') of which the ends go round in the two columns (*ustuwān*) M S [and] N X, in the two holes S Z [? Q]. And it passes alongside of the inside of the wheel F furnished with cogs. And we make in the pillar where it touched the wheel, a screw (*laulab*),³ upon which is D [? R], meeting the cogs of the wheel [F] so that when the screw goes round it makes the wheel F [with the cogs] go round with its turning.

"And we make a water-wheel (*dūlab*) having six float-boards (*burda*),⁴ upon which is S [? Sh] B [? T]. And it is fixed in the middle of the pillar upon which is S W [? Q], on angles (*sāwiya*) arising from the middle of the water-wheel S [Sh] B [T].

"Next, we make two long supports (*ustuwān*), mounting their gear ('*udda*') upon the ends of the large cistern upon which is R [? D] S T X [? H], and we make them removable if we wish that. Upon them is D S X and T D.⁵ And if the need compels us we make four supports. Next, we mount upon them the cistern H D [and] S T, and we make its length 67.5 cm. (= $1\frac{1}{4}$ *dhirā'*) and its breadth 67.5 cm., and its height 27 cm. (= $\frac{1}{2}$ *dhirā'*). And there goes out from the bottom of this cistern a long tap (*bithān*) upon one of the two ends which is X. And we attach it to the bottom of the cistern, and upon the

¹ From the Persian *dandāna* = "a tooth."

² Meaning the angles of a quadrangular pillar.

³ A Persian word.

⁴ The text has *narda*.

⁵ These letters cannot be correct.

The Organ of the Ancients.

other end, and it is that which ends at the water-wheel S B [? Sh T]. And it is possible that we may make the flow of water into the cistern H D S T from a river or from a reservoir in which there is water, in order that this cistern may always be full. Then it is clear that the water, when it goes down from the cistern H D S T, through the tap X A, flows upon the water-wheel S B [? Sh T]. This water-wheel goes round, and with its turning there goes round the screw (*laulab*) upon which is Z [? R], because they are upon one beam (*sahm*), and it is S F [? Q]. So when the screw goes round, the wheel (*dā'ira*) upon which is F goes round (and in it are the cogs). And there goes round with them the half-disc (*nuṣf ḥalqa*) upon which is Z H T in the large cistern, because these two are upon one pillar, and it is L B [? Y] K.

"And it has been explained that when the half-disc upon which is Z H T, is continuous of revolution, the water is continuous of descent into one of the two divisions A J Z H and H Z D B, or into both of them for a short space during the time of the removal when the tap (*bithān*) A D and its like are opened."

Up to this point the Banū Mūsā are describing the wind-producing part of the apparatus, and a design of this is given here which is based on details supplied by the late Professor Dr. Wiedemann (Fig. 8).

The Banū Mūsā then proceed to describe the "organ-pipe," and the automatic arrangement by which it was played.

"Then we make upon every one of the holes of the 'organ-pipe' (*ṣurnāy*)⁶ B H [? Th Kh] up to eight [holes],

⁶The author here drops the term *mizmār* and returns to the term *ṣurnāy*.

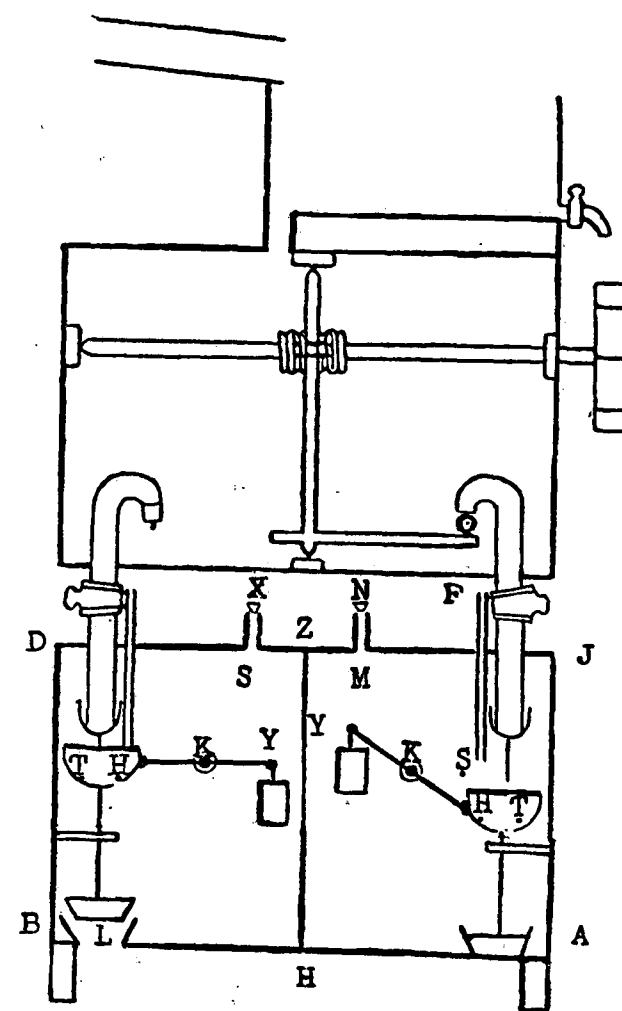


FIG. 8.—THE BANU MUSA AUTOMATIC HYDRAULIC ORGAN. (Reconstructed.)

Showing the three cisterns, (a) The water-cistern, (b) The water-wheel and valves cistern, (c) The air-compressing cisterns, open and shut.

The Organ of the Ancients.

a 'pallet' (*bāb maṭḥān*),⁷ the width of which is according to the width of the hole. And we do not make for the ninth hole a 'pallet' because if these eight are shut, the ninth hole gives its note, and there is no need to close it afterwards. And we fix the 'pull-downs' (*farkh*) of the 'pallets,' I mean the male plugs (*dhakar*), upon the ends of levers (*masṭara*). But in every one of the levers is a pin (*mihwar*), [which makes] the lever work as we have drawn it. Nevertheless we make in the middle of the levers near the bridges (*majāz*) the sign J. And we make the end of every lever upon which the male plug of the 'pallet' is fixed, heavier than the end upon which is D, so that the 'pallet' may close securely by itself. And the end D, when it is touched (*ghamaza*) upon, goes down, [and] the 'pallet' (*ṭabaq al-bāb*) goes up along with the end of the lever upon which is B, which is placed upon it. And when the hole is opened it gives the note which belongs to this hole. And when the end D of the lever is free and is not being touched, the 'pallet' is closed, and there does not go out from this hole any sound at all. And in this fashion the eight holes are opened and closed.

"And as for our composing the notes of the melodies (*lahn*) which we wish [to be played], it is according to what we shall describe. We make a cylinder (*barbakh*),⁸ round, closed at the two heads, its length being according to the distance in which are the eight holes in the 'organ-pipe' (*surnāy*) or rather greater. And the diameter is 27 cm. (= 1 *shibr*) or a little more. Upon it is H W. And we mount in the middle of it a pillar (*amūd*) or square

⁷ Here the nomenclature of organ builders is used, so as to make the description more intelligible.

⁸ The editor of the text says that the *barbakh* is like the *unbūb* or *qasṭal* (a pipe).

The Organ (Hydraulic) from Arabic Sources.

rod (*qaḍīb murabba'*) of brass, upon which is R [? Z] Ḥ, and it will project from its head [? both heads] so that it reaches to the two columns (*usṭuwān*) R [? Z] Ḥ and Ṭ F [? Y] or to the two other columns if there be not these two. And we make its two ends go round in them

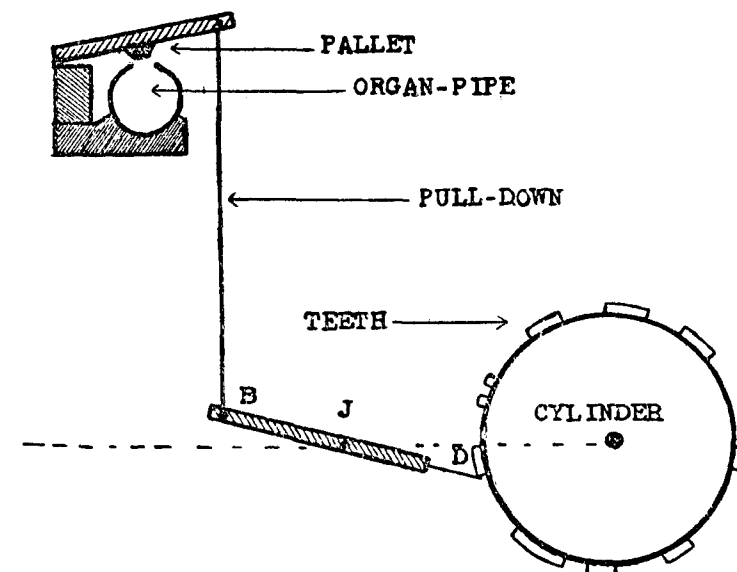


FIG. 9.—THE BANŪ MŪSĀ AUTOMATIC HYDRAULIC ORGAN. (Reconstructed.)

Showing the way in which the teeth of the cylinder or recording barrel opened the holes of the horizontal organ-pipe by means of pallets.

in the two holes R J [? Z Ḥ]. And we prescribe upon the surface (*ṣaḥr*) of this cylinder (*barbakh*) eight discs (*dā'ira*), upon an axis R [? Ṭ] Y and R [? Z] Ḥ, opposite to the eight levers, by the ends of which we open and close the holes which are in the 'organ-pipe' (*surnāy*) as we have mentioned. And we set up upon every one of

The Organ of the Ancients.

these discs which are upon the surface of this cylinder, small teeth (*shāziyya*), their rims (*ḥarf*) being true arcs of a circle. And we put a number of these teeth in one disc which goes round opposite a hole [of the *ṣurnāy*] according to the number of what is desired for which that note is employed which goes out from that hole in that melody in one turn (*daura*) of it [the disc]. And we make the length of this arc (*qaus*), I mean the teeth (*shāziyya*) mounted upon the disc (*dā'ira*) which is opposite that hole, like the space in which that note is employed in that from that melodic scheme (*daur*).⁹

So when we set up these teeth upon each of these discs which are upon the cylinder, as we have described, then the cylinder turns, as we shall describe, [so] that the teeth meet the ends of the nails (*mismār*) upon which are D B H, in the first place. Then, when the one end of it is touched, the hole upon which the other end falls does not cease being opened, and the note goes out from the 'organ-pipe' (*ṣurnāy*), until the tooth (*shāziyya*) passes the end of the lever. Then, that hole closes and another tooth begins to touch the end of another lever, which makes the note which follows it [the previous note] in that melody, go out, whether it be higher or lower than it, and it continues according to the space which that note needs in the melody. And so the one note does not cease going out from the opened hole, and the remaining seven are silent because their 'pallets' (*bāb*) are closed. And that is because the surface of the cylinder does not touch the ends of the levers, for it is only the arcs (I mean the teeth mounted upon the discs which are upon the surface of the cylinder) that touch them, until the space of that

⁹ Any complete melodic or rhythmic sequence is a *daur*.

The Organ (Hydraulic) from Arabic Sources.

note comes to an end, and that which follows it begins, according to the composition of the melody, until the melody is finished with every note and rhythm. And that is [accomplished] in one-third or in half a turn with which the cylinder goes round, if the melody be short. Or, if the melody be long, with one complete turn. Then the melody returns to the beginning.

"Then as for the means of turning the cylinder upon which is H W, it is as we shall describe. We make a great water-wheel of which the diameter is 67.5 cm. (= $2\frac{1}{2}$ *shibr*), upon which is T Y, going round upon a pillar K L, in two holes T L [? Y] from the two columns D T and H D [? Y]. And we make upon the head [? end] W of the cylinder H W, a wheel furnished with cogs (*dandānja*). There meets them a small wheel furnished with cogs also, firmly fixed in the pillar K L. Upon it is M. It goes round with the turning of the great water-wheel upon which is T Y, through the tap N, on account of which the water flows from the cistern S H T L [? D], and is poured upon the water-wheel T Y, until the water [makes it] go round by pushing it and by its weight upon it. Then if this wheel goes round, then it is clear that the cylinder (*bar-bakh*) goes round also, and the eight holes which are in the 'organ-pipe' (*ṣurnāy*) are opened and closed by the 'pallets' which are upon them, and they produce that melody for which the cylinder H W was made. And it repeats it [the melody] until the water is cut off from the water-wheel T Y.

"Then when you wish that the scheme (*daur*) of the melody should be quick sometimes and slow at other times, we make a small cup upon which is S X. And we join, therefore, a lever (*maṣṭara*) fixed to it. Upon it is X F S. It works upon the axis B, and at the end

The Organ of the Ancients.

§ is a weight. When it [the weight] descends, the cup § X ascends until the lever reaches the horizontal, when the cup is empty. Then when we open the tap upon which is W, the water flows from the cistern [? §] Ṭ Ḥ D, descends through it into the cup § X, until it is nearly full, when it descends from its position, and the [other] end of the lever upon which is §, ascends along with the weight suspended from it. Then it opens the valve W [? Q] in the bottom of the cistern [? §] Ṭ Ḥ D. Then the water pours from it upon the great water-wheel Ṭ Y. Then its [the cylinder] turning becomes swift through that, because the water pours upon it from two places, from the tap N, and from the valve W. And for that reason the melody becomes a quick scheme (*ḍaur*) and continues so until the cup S X is empty through the water pouring out of it through the hole S which is in the bottom of it. Then after that, the weight which is suspended at the end § of the lever descends and the valve W shuts, so that no water flows from it upon the great water wheel Ṭ Y. And upon that it slackens the speed of its turning, and the melody returns to its first state, and by reason of that the melody is slow, and it continues so until the cup S X is filled, and descends and opens the valve W, when the quick scheme (*ḍaur*) returns as we have described.

“Then, if we wish to change this organ (*zamr*) so as to play a melody other than that which it already plays, then that may be done by enlarging the cylinder (*barbakh*) H W, until half a revolution of the cylinder gives the melody twice or thrice, and in the other half of the revolution, another melody is given twice, thrice, or more. Then the rule in the second revolution of the cylinder will be like the first, I mean that the first melody will repeat, and

The Organ (Hydraulic) from Arabic Sources.

the other melody will follow it, and so on *ad infinitum*. And in proportion as we enlarge the cylinder (*barbakh*) H W, it becomes more possible to us that we should make in it more than two melodies, so that one of them follows the other, then repeats, and so on.

“And if we wish that we should have this [instrument] in the form of a man who plays, then we will make all of the instrument concealed inside the body of an image, or in another place. And the reed-pipe (*ṣurnāy*) will be shown, inserted in the mouth of the image. And we make those levers (*maṣṭara*) upon the ends of which are the ‘pallets’ (and they are those which shut and open the eight holes of the reed-pipe) the fingers of the image. And we join the ends of the levers D to the inside of the two forearms of the image, until the teeth which are set upon the cylinder H W end in the inside of the image, so that nothing may appear of any part of the instrument except the reed-pipe (*ṣurnāy*), and the fingers of the image which are formed by the fingers [? levers]. Then we free the water in the instrument, and make the ‘wind-chest’ in the mouth of the image, and it (the wind) issues through the ‘sound-box’ (*ḥabba*) and produces the sound in the reed-pipe (*ṣurnāy*), then the fingers move on the reed-pipe as we have described. Then the image plays those melodies which we have composed, just as the wind-instrumentalist plays them, and quickens the rhythm (*īqāʿ*) of the melody and makes it slow as above, and changes from melody to melody as described. And that is what we wish to explain.

“And sometimes it is permissible that we should make the instrument changing from one melody to another, not as we have already described, but by another method.

The Organ of the Ancients.

And that is, that we fashion in the cylinder which produces (*qaṭa'a*) the melodies, an extension of length beyond the eight holes which are in the reed-pipe (*ṣurnāy*), so that when the cylinder turns, the melody may be complete, and shifts from its position towards the direction of its beam (*sahm*) upon which is the axis B [? W] H, by the measure of 27 cm. (= 1 *shibr*) until it agrees with what we have mounted upon the cylinder for another melody. Then there begins the other melody. Then it returns to the first melody. And when we desire, according to this model, that we should change to three or four melodies, and the system proceed, we do so.

"And as for the contrivance in the shifting of the cylinder upon the direction of its beam and its axis, it is quite easy in a number of ways. And one way is that we make the two columns (*usfuwān*) in which are the two holes in which the axis of the cylinder goes round, mounted on two pulleys (*bakra*) like wheels (*'ajala*). And it is worked by a floating vessel (*dabba*)¹⁰ which continually ascends and descends, or by a cup (*ḥauḍ*) which is filled and emptied, and ascends when empty and descends when full. And it works by itself [i.e., automatically] like the *zurnūq*¹¹ which is free of itself. And from different kinds of contrivances made at one time and another we can change this [arrangement].

¹⁰ Carra de Vaux, *Philon de Byzance*, 231. Notice sur deux manuscrits Arabes, 316. Cf. the definition of Professor Collangettes in the *Mashriq*, ix, 454.

¹¹ The *zurnūqān* are the two pillars at the mouth of a well which support the axis of the drum, or the cross-piece (*na'āma*) to which the pulley is attached. It is an Aramaic word, says Baron Carra de Vaux, which in the generic sense means a tube, and is the Greek σὺριγξ = "a flute." See Carra de Vaux, *Philon de Byzance*, 232.

The Organ (Hydraulic) from Arabic Sources.

"And sometimes it is also equipped so that there happens in their change from one melody to another, the choice of these directions which we have mentioned, in that we increase the flow of the water or diminish it, so that he who is present does not see or perceive anything of the instrument [doing this], and it seems to the people that the image has commanded that it should change the melody, and that it obeys him, or else that he commands it to play a well-known melody and it plays it. And by such an arrangement we make the instrument for the turning on of the water, and also with skins (*ziqq*)¹² filled with wind and emptied, or with what takes the place of skins in making the wind go out,¹³ as it is wanted evenly.

"And so that the playing be continuous, it is proper also that we should work the organ (*alat al-zamr*) by means of a donkey or mule that goes round, just as happens in the mills which grind. But that which revolves by means of water, as in the '*araba*',¹⁴ or else what takes the place of the '*araba*' in ships, or elsewhere, is better for making a continuous playing [of the 'organ'] evenly, than that which is contrived by means of animals or by the wind, in any of the devices.

"And according to this same method, it is sometimes proper that we should make an image which plays (*lit.* beats) on the lute (*'ūd*), or on an instrument of strings like psalteries (plur. *ma'āzif*). Then each of the two images conforms to the other, for the 'organ' (*zamr*) conforms to the string [instrument], and the string [instrument] conforms to the 'organ.' And it is also possible

¹² I.e., bellows.

¹³ I.e., pumps.

¹⁴ Wiedemann defines the '*araba*' as "Schiffmühle."

The Organ of the Ancients.

that we should make figures of images which dance and follow this 'organ' and these strings. And the contrivance in all this is like the contrivance of the 'organ,' so that every note of the strings corresponds with every note of the 'organ' to the end of the piece of music (*nauba*).

"And we do not trouble ourselves in this discourse with the construction of the lute and stringed instruments, which we construct according to the melody we want. And if there be in what we have explained a sufficiency to him who has studied geometry (*handasa*) and mechanics (*hiyal*), without its being clear in regard to what follows by a clear proof, we take this and make for it a figure as we have done in the organ.

"And as for the contrivance by which the image succeeds in playing any melody we wish, we make that in two ways. One of them is that we count the beats of the strings in proportion to the duration of the note. Then if the organ be made upon a definite sound (*ṣaut*) and beating (*ḍarb*), we preserve what is in that sound of the beating of the strings in each note successively which is upon it. Next, according to the duration of every note we mount upon the cylinder (*barbakh*) opposite that hole in the 'organ-pipe' (*surṇāy*), a tooth (*shaḥiyya*), of which the size of the whole of the scheme (*daur*) of the melody is in proportion to the number of the beatings of that note from the whole of the beats of the scheme (*daur*) of the melody. Then if it happens that its particular scheme of the melody is in proportion to the [one] revolution of the cylinder exactly, then it is all right. If not, then it is permissible that we should make its scheme (*daur*) more than the melody when we do not use the whole of the revolution of the cylinder, but only a half of its revolution, or a third, or a quarter, or any part.

The Organ (Hydraulic) from Arabic Sources.

"And as for the other way, we take a large wheel (*dā'ira*) of wood or brass, and let its diameter be 108 cm. (= 2 *dhirā'*) and three (fingers ? = 6.75 cm.) more than that. And we put it on the ring (*ḥalqa*) of the large 'drums' (*bakra*) with which the oxen draw water in the large buckets and receptacles according to custom, only that we make the diameter much greater than that. And we smear upon the place which takes the place of the spot where the rope goes round in those drums, black wax like that which the Byzantines (*Rūm*) make, and which they smear upon the slates in the elementary schools, in order that everything that is marked in it may be impressed upon it with a trace which will remain upon it.

"Next, this large drum (*bakra*) is contrived so that the water makes it turn with an even, regular turning, not very swift nor very slow, and that the turning of the drum will be uniform. Then there is mounted above the drum without touching it, an 'organ-pipe' (*surṇāy*). And there is mounted above every hole of the 'organ-pipe,' to the extent of 9 cm. (= 4 *iṣba'*), a lever proportionate in length. And we make the eight levers which are opposite the eight holes which are in the 'organ-pipe,' go up and down (*lit.* 'go round') upon the pins (*miḥwar*) in the direction of one straight line. And their ends, from one side, will fall upon the surface of the drum (*bakra*) on which is the black wax, from that direction, and their other ends, opposite the holes of the 'organ-pipe,' we suspend with strings, tying every string to that finger of the player (*zāmīr*) which is over that hole opposite the lever, in order that when the player raises one of his fingers from any hole of the reed-pipe (*surṇāy*) the lever which ties that finger falls upon the drum (*bakra*). And the drum con-

The Organ of the Ancients.

tinues going round evenly as we have said, and that lever impresses the value of that note on the wax on the surface of the drum (*bakra*).

"Then, if the player plays from the scheme (*daur*) of that melody (*lahn*), we look at the impressions of each lever upon the wax on the surface of the drum (*bakra*), and we know by that the duration (*mudda*) of each note in succession until we can appreciate how each conforms to its original. Next, we make the cylinder, which was made in order to produce [*lit.* 'cut'] the notes, note for note, as we have described, in accordance with the impressions on the wax. And that is what we wish to explain.

"And there is incumbent upon us in regard to the organ that we should explain the state of the notes which are in the flute (*nāy*) and in the lute (*'ūd*), and which note of the flute corresponds with the note of the lute in the consonance (*ittafāq*), that is, in equality (*musāwāt*). And they correspond in the octave (*qit'*) and in the remaining ones in the consonances. So we begin and say,—Verily, in every flute (*nāy*) and reed-pipe (*surnāy*) also, are nine notes whose outlet is from nine holes which are in it. And the custom has been that eight of these holes should be closed by the fingers and opened by the fingers. And the ninth hole is always left open, and it is that which is at the end of the flute or reed-pipe. And the note from this ninth hole sounds only [*lit.* 'appears'] whenever the eight holes which are higher than it, are closed. And similarly, every other hole [sounds only] when it is opened, and when the holes higher than it towards the mouthpiece are shut. Then the note goes out from it [the first open hole] and belongs to it.

The Organ (Hydraulic) from Arabic Sources.

"And if the whole of the holes which are after it are open, then the note of the 1st hole, and it is that which is next to the mouthpiece [Here, says the editor, a line has been missed out in the text, and it should run,—'And the 1st hole is equal to the sound which goes from under the 4th finger [g]¹⁵ on the *Zir* string [c],¹⁶ and [double of]¹⁷ the open string of the *Mathnā* string [G]]. And the 2nd [hole] is equal to the 4th finger [f] of the *Zir* string, and double of the 2nd finger [F] of the *Mathlath* string [D]. And the 3rd hole of the flute is equal to the 3rd finger [e] of the *Zir* string, and double of the 1st finger [E] of the *Mathlath* string. And the 4th hole is equal to the 1st finger [d] of the *Zir* string and double of the open *Mathlath* string [D]. And the fifth hole is equal to the [open note of the] *Zir* string [c], and double the 2nd finger [C] of the *Bamm* string [A]. And the 6th hole is equal to the 3rd finger [b] of the *Mathnā* string [G] and double the 1st finger [B] of the *Bamm* string [A], and I have found it softened (*bi'l-miḥna*) as the 2nd finger [F [? B flat]] of the *Mathlath* [? *Mathnā*] string. And the 7th hole is equal to the 1st finger [a] of the *Mathnā* string, and double the open *Bamm* string [A]. And the 8th [hole] is equal to the open *Mathnā* string [G], and it is also half the note of the 1st hole [g]. And the 9th hole is like the 2nd finger [F] of the *Mathlath*

¹⁵ Under the fourth finger means the fret lower down (towards the bridge) on the fingerboard.

¹⁶ The Arabs refer in all their musical theory to their lute, just as the Greeks used the kithara. The four strings of the lute were, A (*Bamm*), D (*Mathlath*), G (*Mathnā*), and C (*Zir*).

¹⁷ Double = octave.

The Organ of the Ancients.

string, and half the note of the 2nd hole, which note is like the 4th finger of the *Zir* string, just as we have explained.¹⁸

"And it is proper that we should examine in the organ, the valves (*bāb*) and fingers, to see that they close properly for the production of the notes. And we should inspect the inside of the 'organ-pipe' (*surnāy*) so that there may not be in it any dust, or anything that would spoil the tone. And the organ-pipe should be softened with oil, and there should be put upon the valves which take the place of the fingers, Chinese fat, or thick fat, so that they may close [properly] in the production of the notes, and not leak. And we should inspect the fixing-place of the 'sound-box' (*ḥabba*) upon the mouth of the 'organ-pipe' (*surnāy*), in order that there may not be a leakage from its sides. And we should inspect the 'plug' (*ṣimām*) in

¹⁸ Here is the fretting and *accordatura* of the lute.

	BAMM	MATHLATH	MATHNĀ	ZIR
	A	D	G	c
Sabbāba.	B	E	a	d
Wustā.	C	F	bḏ	eḏ
Binşir.	C#	F#	b	e
Khinşir.	D	G	c	f
				g

The Organ (Hydraulic) from Arabic Sources.

which there is a tap (*bithān*) and [see to] its precise fitting (*hindām*). And if it be mounted, its tap should work easily that it be not locked. And we inspect the tap which shares the two pipes of the air so that each one is opened in its time. And we inspect the two water-wheels, and the turning of the drum (*ṭabl*). And we inspect the two valves from which the water enters into the house [= division], so that each one is opened in its time, and when it is opened the water is poured from it into the little cup (*ḥauḍ*), which is in the great house. And this little cup is that which opens the lower valve. And it is necessary that we should be on the look-out lest one of the two houses [= divisions] be filled with water, for when it is filled, the little cup will not empty, and the lower valve [at the bottom of the division] will not open. And if one of the two houses [= divisions] be filled with water, it is necessary that the lowest valve should be opened with the hand, so that the proper amount may be emptied from it until the little cup is emptied, and the door is opened. And we must examine the two lowest valves, for each one of them must be opened if the house be empty. Then when the water pours into one of these houses [= divisions], it begins to pour into the small cup, and when the small cup is full and heavy, the valve which is at the bottom of the house is closed. And we must examine the places which are stopped up with wax in the air pipes, and what is between the air-pipe and the 'organ-pipe' [that is the *kurra* and wind-chest]. Next, we inspect also, the two houses [= divisions] in order that each one of them may be air-tight, and that air may not be diverted from it and go out by the valve by which the water enters. And we examine the 'sound-box' (*ḥabba*) and its sound, before it is mounted, so that it is pure of tone, and that there

The Organ of the Ancients.

is not in it a hair or particle of dust, which would spoil it, so that they are entirely subservient (*maftūh*) to the two houses [= divisions]. And we must inspect the air-pipe [which enters] the house [= division] into which the water pours, so that it may be open when the water is being poured into its house [= division]. And we examine the revolution of the water-wheel (*dālāb*) which turns the wheel (*dā'ira*) in order that it may open the two valves, so that it may not be too swift nor too slow. For if it were slow, it would result that one of the two houses [= divisions] would be filled with water, and the valve of the other house would not have been opened, nor would there have entered into it the water. So the air would be cut off by that from the 'organ' (*mizmār*), and the house also will have been filled with water, and its lower valve will not open unless one opens it with his hand and empty it, because the little cup which opens the lower valve will not open if the house be filled with water.

"The [description of the] instrument is finished with the power and strength of Allāh."

This *automatic hydraulic organ* of the Bānu Mūsā is a most interesting instrument, for whilst the principle of the wind supply is little different from that of the automatic wind-instrumentalist of Apollonios, as found in Arabic documents, yet it is an improvement, and the remaining part of the apparatus is certainly quite novel.

The Reverend Professor Maurice Collangettes suggests¹⁹ that the instrument delineated by Kircher in his "Musurgia Universalis" (1650)²⁰ "resembled in every way the in-

¹⁹ *Mashriq*, ix, 457.

²⁰ *Iconismus*, xxii. See, however, the instrument on p. 334 (*Machinamentum*, ii).

The Organ (Hydraulic) from Arabic Sources.

strument which the Banū Mūsā describe." This is not quite correct.¹ The principle of the wind supply was different. In the Banū Mūsā instrument, as in the Apollonios instrument, the wind supply was obtained by means of compensating water cisterns called divisions in the text. Each of these cisterns alternately, was filled with air through a valve at the bottom. When the water flowed upon a movable cup in a cistern, the cup descended and closed the valve. The water pouring into the cup, overflowed, and accumulated in the cistern, thus driving the air out of the cistern into the compartment called the *kurra*, which fed the wind-chest and so the "organ-pipe."

The *kurra* in the Banū Mūsā instrument served the part purpose of the *pnigeus* of Herōn and the *infundibulum inversum* of Vitruvius; that is to say, the air was compressed in these contrivances, although the function of the water in the two instruments was different. In the Banū Mūsā instrument we have a *hydraulic air compressor*, whilst in the Herōn-Vitruvius instrument we have a *hydraulic pressure stabiliser*. Passing from the *kurra* through the *'unq* (= *cervicula* of Vitruvius), the wind reached the *rukba* or wind-chest, which was the *sōlēn plagion* of Herōn and the *arcula* of Vitruvius.

That part of the apparatus which "cut" the melody, as the Banū Mūsā say, is also clearly described. Here we have a cylinder furnished with teeth (*shāziyya*) arranged according to the needs of the melody, as in the modern barrel-organ. These teeth touched the ends of levers (*mas'ara*) that moved "pallets" which opened or closed the holes of the "organ-pipe" (*surnāy*).

Clearly, this organ did not possess a number of pipes

¹ See Appendix III for Kircher's instrument.

The Organ of the Ancients.

as in the case of the ordinary organ. Only one pipe was used, and this was pierced with a number of holes, in precisely the same way as a flute or reed-pipe. These holes were covered with keys called "pallets" which were opened and closed by the action of levers (see Fig. 9).

As for the class of organ-pipe, we are left in some dubiety as to whether it was a flue-pipe or a reed-pipe. On account of the use of the word *surñāy*, one might conclude that it was a reed-pipe. On the other hand, that part of the instrument which has been named the "sound-box" is termed the *ḥabbat al-muṣawwita* ("the sounding ḥabba"), and because of this, a flue-pipe suggests itself. A *ḥabba* is "a grain," and in one of the designs of the Apollonios instrument, the "sound-box" or *mauḍa' ḥabba* is delineated with a number of grains in the box, which would operate in the same way as the grain does in our modern whistles. At the same time, the term *ḥabba* has a wider meaning, and stands for "the core of a thing," hence "that which is needful or requisite," which would simply mean that the "sound-box" was so named because it was "the principal part of the instrument."

Curiously enough, another term for the same part of the instrument is *sha'ira*, and this also means "a grain." This word is used by Al-Fārābī (d. c. 950) for the head of the *suryānai* (? *surñāy*), which is the place of blowing.² Muḥammad ibn Aḥmad al-Khwārizmī (fl. 976-97) says that the *sha'ira* of the *mizmār* "is its head, and it is that by which it is made narrow and wide [in compass]."³

Happily, the scale of the Banū Mūsā "organ" has been preserved for us. Here it is:

² Land, *Recherches*, 164.

³ *Maḥāṭib al-'ulūm*, 237.

The Organ (Hydraulic) from Arabic Sources.

Notes. F. G. a. (bḡ). b. c. d. e. f. g.
Cents. O. 204. 408. (498). 612. 702. 906. 1110. 1200. 1404.

In the treatise entitled the *Maḥāṭib al-'ulūm*, by Al-Khwārizmī, a writer mentioned above, certain "instruments of motion" (*ālāt al-ḥarakāt*) called *ḥannānāt* (sing. *ḥannāna*) are included. They are described as instruments that make a plaintive sound like the sound of psalteries or barbitons (*mi'zafa, mi'zaf*), and reed-pipes (*miz-mār*), and flutes-a-bec (*ṣaffāra*).⁴ Does this refer to automatic instruments of the Banū Mūsā type? Ordinarily, the *ḥannāna* was a hydraulic wheel, and it was probably given this name by reason of the sound that it made ($\sqrt{\text{ḥannu}}$ = "the twang of a bow"). The music of water-wheels captured the fancy of the Arabs, and we often read of them sitting enjoying their music.⁵ Even Burton, on his pilgrimage to Mecca and Al-Medina, was so captivated by the delightful music that the whistling water-wheel made at Qubā' that he left off praying.⁶ It is not improbable, therefore, that the description of Al-Khwārizmī is merely fanciful. On the other hand, the *ḥannānāt* described in the Arabic version of Philōn's *Pneumatics* were constructed so as to produce a whistling sound.⁷

We have already mentioned a certain Abū Zakariyyā Yaḥyā al-Bayāsī (late twelfth cent.), who constructed an organ (*urghan*) "and sought by artful contrivance the playing of it."⁸ This may have been a similar sort of instrument to that described by the Banū Mūsā. We know

⁴ *Ibid.*, 254.

⁵ Al-Maqqarī, i, 68.

⁶ Burton, *Personal Narrative* . . . , ii, 217.

⁷ Carra de Vaux, *Philon de Byzance*, Nos. 61, 62.

⁸ See *ante* p. 75.

The Organ of the Ancients.

from the writings of Badi' al-Zamān al-Aṣṭurlābī (d. 1139-1140), and Badi' al-Zamān al-Jazari (fl. 1205),⁹ who were in the service of the Saljūq sultāns and Urtuqid rulers respectively, that mechanical instruments of this type were still in favour.

⁹ *Der Islām*, viii, 55, 57.

CHAPTER VII.

THE ORGAN FROM ARABIC SOURCES.

(THE HYDRAULIS.)

"The revival of interest in the *hydraulis* in Europe appears to have been due to the Arabs. From the sixth to the ninth century there is no mention of the ancient *hydraulis* in Europe, but in the ninth-twelfth century the Arabs were actually constructing both the pneumatic and the hydraulic organ."—Farmer, *The Arabian Influence on Musical Theory*.¹

THE *hydraulis* proper, that is to say, the apparatus that gave us an *hydraulic pressure stabiliser*, such as we find in Herōn and Vitruvius, was also known to the Arabs from an early period. The earliest reference in Arabic to an instrument of this type is to be found in a work entitled the *Kitāb al-siyāsa*, attributed to Aristotle, where a large *hydraulis* is mentioned as being used in times of war.²

¹ I quote this passage from my brochure because my conclusions have been challenged by Miss Kathleen Schlesinger in a "reply" entitled *Is European Musical Theory Indebted to the Arabs?* My critic says: "Mr. Farmer will find a record of a fine *hydraulic organ* constructed in the palace of Louis le Débonnaire." This *organum hydraulicum* was constructed in 826 or 828, and it was on that account that I introduced the words "ninth century." When I said "from the sixth to the ninth century" I meant "from the close of the sixth century to the opening of the ninth century."

² British Museum MSS., Or. 3118 and Or. 6421. John Rylands' Library, Arab., 455.

The Organ of the Ancients.

This warlike *hydraulis* is said to have been used by Alexander the Great (356-323 B.C.), but the story probably belongs to the mythopœic period of the third century A.D., when most of the other legendary Alexander material arose. The immediate authority for the statement, however, is the Arabic treatise entitled the *Kitāb al-siyāsa* ("Book on Government"), which claims to be a translation from the Greek, via the Syriac, made by Yūḥannā ibn al-Baṭṭīq (d. 815).³ The translator's preface informs us that this book was composed by Aristotle for his pupil, Alexander the Great! No Greek original is known, and no Syriac version has yet come to light. Mr. Robert Steele, the editor of Roger Bacon's *Secretum Secretorum*, which was derived from the Arabic *Kitāb al-siyāsa*, opines that the work, as it stands, can scarcely be of Greek origin, although Greek treatises have found a place therein. "The texture itself of the original work," says Mr. Steele, "is oriental, not western. I believe it to have had its origin in the interaction between Persian and Syriac ideas which took place in the seventh to ninth centuries of our era."⁴

The *Kitāb al-siyāsa* is not mentioned in the *Fihrist* (written 988), nor by Ibn al-Qifṭī (d. 1248), although it is mentioned by Ibn Khaldūn (d. 1406)⁵ and Ḥajjī Khalifa (d. 1658).⁶ Yet we have evidence of its existence in the

³ MSS. are to be found in many European libraries—British Museum, the Bodleian, John Rylands (Manchester), Paris, Vienna, Gotha, Leyden and Berlin. It has been translated into English by A. S. Fulton, who collated six MSS. for the purpose. It may be found in Steele's edition of Roger Bacon's *Secretum Secretorum* (Oxford, 1920).

⁴ Op. cit., x.

⁵ Ibn Khaldūn, i, 210.

⁶ Ḥajjī Khalifa, No. 10202. See also No. 7102, which is evidently another recension of the same work.

The Organ from Arabic Sources (The Hydraulis).

twelfth century, since it was translated into Latin from the Arabic by Johannes Hispalensis (c. 1135),⁷ whilst a Hebrew version was made shortly afterwards by Judah al-Ḥarizi (fl. 1190-1218).⁸ Another Latin translation from the Arabic was done by Philip of Tripoli (c. 1243), a version which is reflected in the *Secretum Secretorum* of Roger Bacon (d. c. 1294).

The Arabic texts disclose two distinct recensions, now distinguished as the Eastern and Western texts. That portion of the Arabic *Kitāb al-siyāsa* which deals with the *hydraulis* is of sufficient interest to be quoted here.⁹

"And it is necessary that there should be with thee the instrument which Yāyastayūs¹⁰ invented for warning (people).¹¹ And it is a pneumatic instrument¹² used for various purposes, because it enables you to warn all your country, and prepare the troops the same day for advancing or retiring, or any other purpose necessary in a mighty army. And its sound will be heard sixty miles."

Another passage reads:¹³

⁷ Steinschneider, *Jüdische Uebersetzer des Mittelalters*, 981. The text is given in H. Suchier's *Denkmäler provenzalischer Literatur und Sprache* (1883), 472 et seq.

⁸ Text and translation in the *Journal, Royal Asiatic Society*, 1907-8.

⁹ I have edited the text in my *Studies in Oriental Musical Instruments*, p. 28. The text is based on two British Museum MSS. Or. 3118 (called "C"), and Or. 6421 (called "D"), as well as on the John Rylands Library MS., Arab., 455.

¹⁰ Called Thāsītūs and Thāsīyūs in MS. "D," and Temistius in the Latin versions. See *ante* p. 19.

¹¹ Roger Bacon has *ad nocendum*, which Steele suggests is a mistake for *advocandum*, as in the Holkham Hall MS.

¹² MS. "C" has *mafza'a* ("terrifying"), which agrees with the word in Roger Bacon's version. MS. "D" has *mufarrigha* ("pneumatic").

¹³ Steele, p. 248. Mr. Fulton's translation.

The Organ of the Ancients.

"And let there be plenty of frightening and terrific sound-producing instruments, for verily they will inspire thy men with courage and those of thy enemy with fear."¹⁴

The Hebrew version closely resembles the Western Arabic text, and it was obviously made from it, as was the Latin version of Johannes Hispalensis. Philip of Tripoli used the Eastern text. In the Hebrew version we are specifically informed that they were "*hydraulic* instruments." The Hebrew text says:

"Provide [thyself with] . . . terrifying instruments which make horrible noises, for thereby thou wilt encourage thy army and strengthen their souls, and thou wilt frighten those with whom thou wagest war, and dread will enter their souls. . . . And thou shalt dispose thy army. . . . On the left . . . those hydraulic instruments which cause dread and trembling, which I have made for thee when thou didst engage with B.l.h.h the Indian. When they heard those frightful noises their hearts quaked, the horses ran away, and thy victory was due to the large number of these instruments which I have mentioned."

Curiously enough, however, it is the Latin version of Roger Bacon, which appears to give a reading more like what, it may be presumed, the original Arabic was. It is as follows:¹⁵

¹⁴ The Western Arabic text reads: "Instruments which cause dread and trembling, which I made for thee when thou didst engage in battle against Nahala the Indian. When they heard those frightful noises their hearts quaked, the horses ran away, and thy victory was due to this." The Western version may be seen in *Land Or.* 210, Bodleian Library.

¹⁵ Steele, op. cit., 151. Quoted verbatim.

The Organ from Arabic Sources (The Hydraulis).

"Et oportet te tecum habere illud instrumentum quod fecit Temistius ad opus excercitus ad nocendum, et est instrumentum terribile quod dividitur multis modis, quia forte oportebit te vocare totam provinciam tuam et regnum tuum, et congregare subito proceres tuos bellatores tuos in eadem die vel cicius, vel aliquo modo prout indiget excercitus magnus et numerosus, nam hujus instrumenti sonus auditur per miliaria sexaginta. Hoc est cornu eneum artificio mirabili fabricatum, quo ex lx. miliaris tempore bellisuum excercitum convocabat, et regebatur cornu sexaginta hominibus propter sui magnitudinem et inestimabilem artificium, et verisimile est quod multa metallorum resonantium genera in ejus compositione concurrebant, et hec est forma cornu."

"And it is necessary for you to have that instrument which Temistius made for the need of the army in order to affright. And it is a terrifying instrument used for various purposes. Because it will enable you to summon the whole district, and even your kingdom, and assemble the military officers the same day or more speedily, or in any way that is required in a large and numerous army, for the sound of this instrument carries sixty miles. This is a bronze horn of wonderful artifice. In time of war it convokes an army for sixty miles, and the horn is manipulated by sixty men on account of its bulk and enormous structure. And doubtless, many kinds of resonant metals are incorporated in its construction, and this is the form of this horn."

The form is not given in the Bacon MSS. Mr. Steele says that "no Latin MS. is known in which there is a figure of the horn, with the exception of that in Holkham

The Organ of the Ancients.

Hall, in the borders of which an entirely fanciful instrument is depicted."¹⁶ Professor Lynn Thorndike points out, however, that a figure may be found in a Munich MS. (2574b, fol. 69v).¹⁷ Achillini, in his 1501 and 1516 editions of the *Secretum Secretorum*, gives a woodcut of the instrument, which is, however, purely imaginary. This design was clumsily reproduced by Kircher in his *Ars magna* (1646),¹⁸ and also in his *Phonurgia nova* (1674).¹⁹ Kircher records the diameter of the horn as five cubits, and the distance at which it could be heard as one hundred stadia, but he does not declare his authority for these statements.

The Holkham Hall design, which has been reproduced in the facsimile of the *De secretis secretorum Aristotelis* issued by the Roxburghe Club, is not so "entirely fanciful" as Mr. Steele suggests. Clearly, the artist must have had some "authority" for his conception of the "Horn of Temistius" as an organ.²⁰ It is almost inconceivable that he merely guessed it. Failing a design in a MS. from which the text was copied, the artist may have been prompted by the reference to "hydraulic instruments," such as we read about in the Hebrew version, which may have also occurred in some Latin version.

The question of the name Temistius in the Latin, and Yayastayus in the Arabic version, has considerable interest. Mr. Steele suggests that "the name Temistius or Themistius . . . seems to be taken from *The Book of*

¹⁶ Op. cit., lviii.

¹⁷ Thorndyke, *A History of Magic and Experimental Science*, ii, 265.

¹⁸ Page 140.

¹⁹ Page 132.

²⁰ *The Treatise of Walter de Milemete . . . et De secretis secretorum Aristotelis*. Edited by M. R. James. Printed by the Roxburghe Club, 1913, pl. 151.

The Organ from Arabic Sources (The Hydraulis).

Astamatis described by Al-Makīn."¹ I believe that a more likely solution may be found elsewhere, as has already been hinted.²

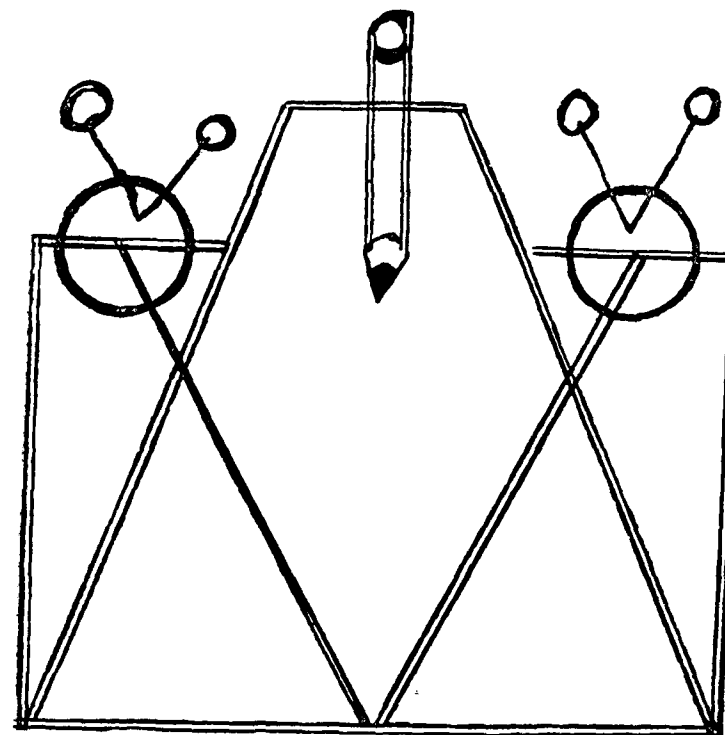


FIG. 10.—THE "KITAB AL-SIYASA" HYDRAULIS.
British Museum MS., Or. 3118.

From the descriptions in the *Kitāb al-siyāsa* and the *Secretum Secretorum* alone it would not have been possible to have identified the instrument they mention as the

¹ Steele, op. cit., lviii. See Budge, *Alexander*, ii, 384, for reference to this work. Al-Makīn (d. 1273) was the son of an unfrocked Christian monk.

² See ante, p. 19.

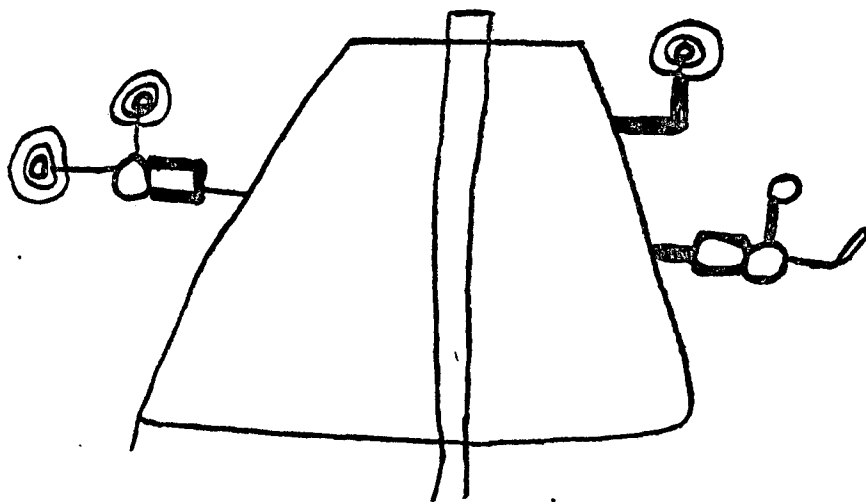


FIG. 11.—THE "KITAB AL-SIYASA" HYDRAULIS.
British Museum MS., Or. 6421.

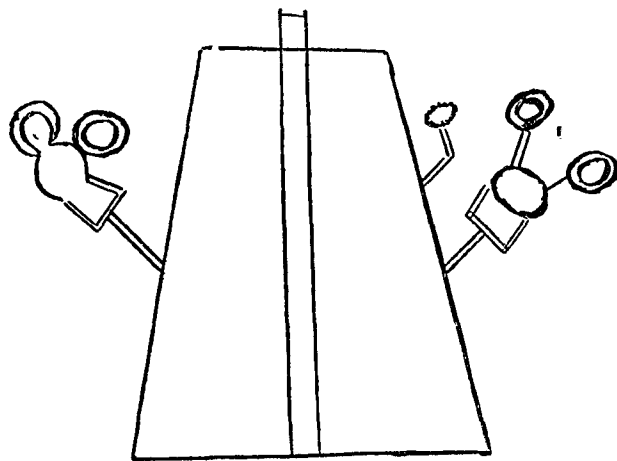


FIG. 12.—THE "KITAB AL-SIYASA" HYDRAULIS.
John Rylands Library MS., Arab., 455.

The Organ of the Ancients.

hydraulis, had it not been for the designs of the instrument which appear in the former MS. and the mention of its sound being heard "sixty miles." Figs. 10, 11 and 12 show the three designs in the Arabic manuscripts mentioned.

These designs are rather crude, but in Fig. 10 we have the *infundibulum inversum* of Vitruvius (= *πρυγέως* of Herōn and the *unbūb* of Mūristus) set within the *ar[c]a* of Vitruvius (= *βωπιόρκος* of Herōn, and the *āla* of Mūristus). The former lacks the water space at the bottom, but otherwise it is a fairly correct design. The cylindrical bellows shown on either side, called by Mūristus the *ziqq rūmī*,⁴ equates with the *πυγίς* of Herōn and the *modiolus* of Vitruvius. Two of the figures also delineate the water funnel.

It is in the Mūristus documents, however, that we get a full description of the *hydraulis*. Already it has been pointed out that we have copies of the Mūristus treatises in the British Museum, Constantinople, and Bairūt libraries, the last copy dating from the twelfth century, whilst the works themselves can be traced to the tenth century, and probably to the ninth century.⁵

In the Bairūt copy of the treatise on the *hydraulis*, the actual invention of the *hydraulis* is credited to Mūristus. The treatise is entitled, '*Amal al-ālat illatī ittakhadhahā Mūristus yadhhabu šautuhā sittīn mīlan*' ("Construction of the Instrument which Mūristus Invented, the Sound of which Travels Sixty Miles"). The title of the British Museum and Constantinople copies runs, '*Risāla li-Mūristus šan'at al-urghīn al-būqī*' ("Treatise by Mūristus on

⁴ See my *Studies in Oriental Musical Instruments*, p. 30.

⁵ See *ante*, p. 16 et seq. Gastoué (*L'orgue en France*, p. 30) says "eighth century."

The Organ of the Ancients.

the Construction of the Flue-pipe Organ"). This treatise describes a type of *hydraulis* far earlier than those of Herōn and Vitruvius, and whether this is actually the original work of Ktēsibios, as suggested, or not, it is a most interesting addition to the literature of the *hydraulis*. For that reason a complete translation of the treatise is given herewith.

THIS IS THE TREATISE OF MURISTUS ON
THE CONSTRUCTION OF THE FLUE-PIPE
ORGAN, THE SOUND OF WHICH CARRIED
SIXTY MILES.

Mūristus says: This instrument was carried with them [the Greeks] in their wars because their country had enemies on all sides. And when they were needing that they should warn their fellows or ask for assistance in the wars, to send them the cavalry and succour, or warn the people of the capital of the kingdom or any territory whatever, they sounded upon (*lit.* blew in) this instrument. And it is the Great Organ, nicknamed 'The Capacious Mouth with the Loud Voice.' And that is because its sound⁴ carries sixty miles.

Then in order to make it, one takes an apparatus (*āla*) of brass according to the distance that one requires the carrying-power of the sound to be, greater than we state, or less. Then, as for that which I personally made for the King of the Inner Franks (*Aḡranjat al-dākhila*) it was the distance that I mentioned. And its capacity was

⁴The *Mashriq* text has a wrong word here. "Sound" (*ṣaut*) is the word intended, which is clearly borne out by the other texts.

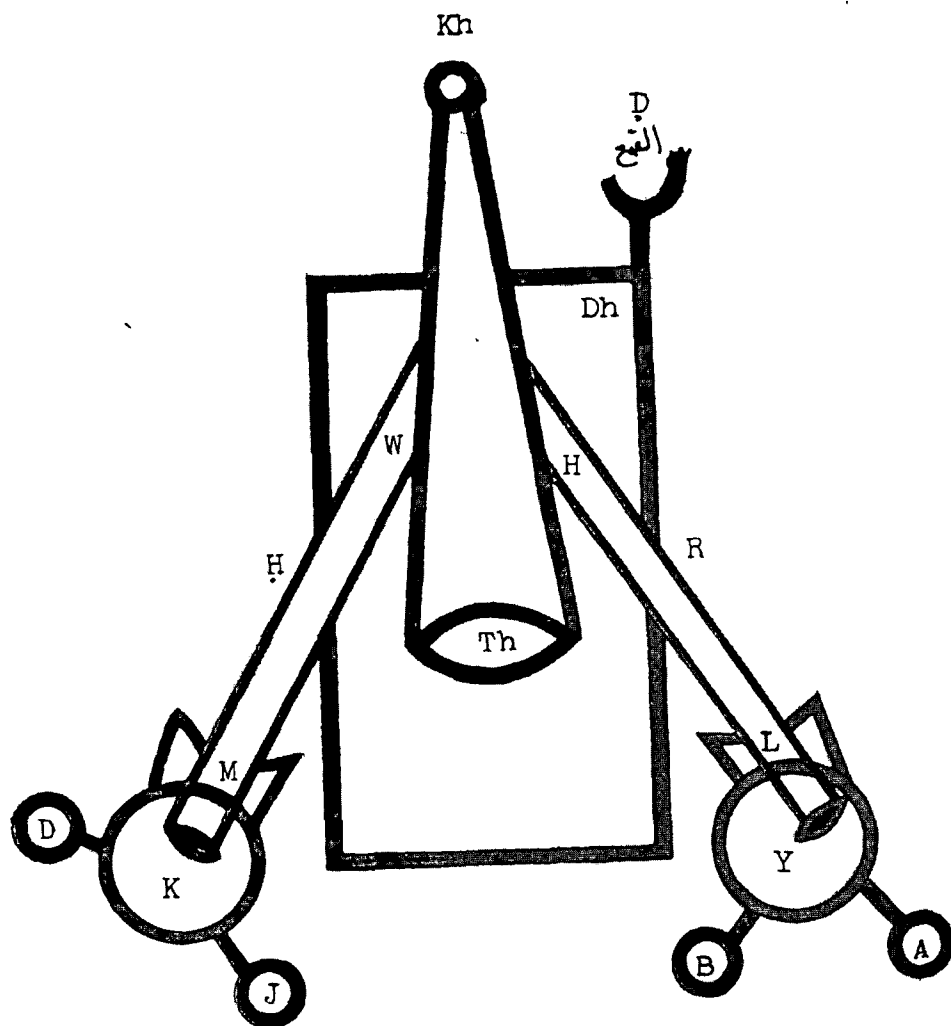


PLATE 2. THE MÛRISTUS HYDRAULIS.
(*Al-āla yadhhabu sittin milan.*)
Bairūt MS. (*Al-Mashriq*, ix.)

The Organ from Arabic Sources (The Hydraulis).

1,000 *qist*,⁶ and its height 648 cm. (= 12 *dhira'*), and the circumference of its base 945 cm. (= 35 *shibr*).⁶ And let its base be broad, and as it rises to its top, it gets narrower, until the opening at its head becomes the amount of 81 cm. (= 3 *shibr*), like the form of the oven (*tannūr*). And it is roofed, that is to say covered. And it is perforated in its upper part, in that place 27 cm. (= 1 *shibr*) below its head, with three holes. And these holes are in a triangle. And between the holes there is an equal distance,⁷ a third of the circumference of the apparatus.

Then take three skins (*ziqq*), each of a large buffalo hide, and tan them well. And the excellence of the tanning will be that it is soft, thin, compact. Let there be inserted into the mouth of each skin, a pipe of brass, the same length as the apparatus, in such a way that if the end of the pipe which is in the skin⁸ be put in the head it would nearly reach to the bottom⁹ of the apparatus. And these pipes will be made flexible (*laina*),¹⁰ broad at the bottom, and in proportion as they rise they get narrower, until they get to a size which I shall describe.

And thus the head of the pipe which is upon the head of the apparatus has an opening of 2.25 cm.

⁶ The British Museum text has *musht*, but the other texts have *qist*. A *qist*, according to the Arabic lexicons, is a "bushel," but the above dimensions would seem to show that the Greek ξέστης (= "pint") is intended. See Carra de Vaux, *L'Invention de l'hydraulis*, p. 334.

⁶ The British Museum MS. has 30 *shibr*, but both the *Mashriq* and Constantinople texts have 35 *shibr*.

⁷ Meaning an equilateral triangle.

⁸ The Brit. Mus. MS. has "hole" (*thagb*) instead of "skin," as in the other texts.

⁹ The Brit. Mus. MS. has "pipes" instead of "bottom," as in the other texts.

¹⁰ The Brit. Mus. MS. and the Constantinople text have "also" (*aidan*) instead of "flexible" (*laina*).

The Organ of the Ancients.

(= 1 'aqd'), and the head of the pipe at the bottom of the apparatus has an opening of 27 cm. (= 4 *işba' maftāḥ*).¹¹ And likewise the size of the holes [in the apparatus] which take these pipes.

And let the broad ends of these three pipes enter the holes of the apparatus which are at its head, each pipe projecting the measure of 40.5 cm. (= 1½ *shibr*). Then take [each of]¹² the three skins, and let its mouth, and it is its head, be tied over every one of these pipes [going out]¹³ from the head of the apparatus, so that it is fixed securely so that there is not to it an escape of wind in the slightest degree.

[And the apparatus is marked by A B J D. And the lid is that which has A B upon it. And the bottom is that which has J D upon it. As the design is a plane and not a body, we show, instead of the three holes in a triangle, only two holes, R¹⁴ and H. And of the three skins we show only two skins, and they are Y and K. And of the three pipes we show only two pipes, and they are L H and M W. And the two ends H and W penetrate the apparatus, and the two ends M and L are in the head of the skins,¹⁵ and they are K and Y.]¹⁶

Then we pierce¹⁷ in every skin at its back, two wide holes, the width of each being 27 cm. (= 4 *işba' maftāḥ*) or 18 cm. (= 4 *işba' maḍmūm*). And let there be mounted upon each hole a pipe, the length of each pipe being

¹¹ The measurements for the two ends of the pipes are reversed in the *Mashriq*.

¹² Not in the *Mashriq* text. ¹³ In *Mashriq* only.

¹⁴ The Brit. Mus. MS. has Z in text but R in design.

¹⁵ The Brit. Mus. MS. says "head of the apparatus."

¹⁶ The passage in square brackets does not appear in the *Mashriq* text.

¹⁷ The *Mashriq* text has "make" instead of "pierce."

The Organ from Arabic Sources (The Hydraulis).

40.5 cm. (= 1½ *shibr*). And the ends of the pipes outside shall be narrow, the size of 2.25 cm. (= 1 'aqd) each, and these pipes shall be fixed in their places with a firm fixing in order that the wind may not escape from them. And let there be taken for each of these pipes, a Greek bellows (*ziqq Rāmī*) [and it is the cylindrical bellows which the goldsmiths blow who make seals].¹⁸ And mount these [bellows] upon the ends of the small pipes which are in the back of the skins. And this is the place for the driving of the wind into the skins [and] then into the apparatus. Understand that.¹

And the two holes which are in the skin Y are F and X, and the two in the skin K are N and S. Then the pipes fastened to these holes are marked, Ş-Q² F-X, Z³-N S-Sh. [And the Greek bellows are marked A B J D.]⁴ Know that.

Then take a receptacle (*lit.* pipe) exactly after the form of the particular make of the apparatus (*āla*). And let the width of its lowest part be 40.5 cm. (= 1½ *shibr*), and the width of its head 18 cm. (= 4 *işba' maḍmūm*). And let the length of this receptacle be the amount of a third in excess of the height of the apparatus. Then pierce the head of the apparatus with a hole and insert in it this receptacle, and there will be of its length outside the head of the apparatus the amount of 27 cm. (= 1 *shibr*).⁵

¹⁸ The passage in square brackets does not appear in the Brit. Mus. MS.

¹ These last two words are omitted in the Brit. Mus. MS.

² Brit. Mus. MS. has F instead of Q.

³ Brit. Mus. MS. has Z in the text but D in the design.

⁴ The passage in square brackets only appears in the Brit. Mus. MS.

⁵ The *Mashriq* text has 2 *shibr*.

The Organ of the Ancients.

Then let the soldering of that be made firm with lead, so that no air will get out at all. And let the bottom of this apparatus be solid.

Then mark the hole upon the head of the apparatus T, and mark Th-Kh upon the receptacle which resembles the apparatus, and it is inserted in this hole. And the end Th enters almost to one-third of the apparatus, and the end Kh projects out of the hole T to the extent of 27 cm. (= 1 *shibr*).⁶

Then pierce a hole below the head of this apparatus [A. B. J. D.]⁷ at a distance of 54 cm. (= 1 *dhirā'*) from the head, and mount upon it a strong stopper (*bithān*), upon the head of which is a funnel (*qam'*) for the pouring in of the water. And in the bottom of the apparatus also there is a stopper for the flowing out of the water. Then the hole for the pouring in of the water is marked Dh, and the funnel D,⁸ and the hole for the pouring out of the water at the bottom of the apparatus Z,⁹ and the stopper Gh.¹⁰ Then let water be poured into the funnel D, and it flows out of the hole Dh into the apparatus [A B J D] until the water level reaches the face of the upright receptacle in it,¹¹ that is to say until it reaches the opening Th of the receptacle marked Th-Kh, and it is from this that the sound [? the wind] goes out. Then close the stopper Dh-D.¹²

⁶ This paragraph is not in the *Mashriq*.

⁷ Only in the Constantinople MS.

⁸ Marked § in the Brit. Mus. design.

⁹ Marked T in the Brit. Mus. text.

¹⁰ Marked X in both text and design, but it is Gh in the Constantinople text.

¹¹ The *Mashriq* text adds "in the middle."

¹² The *Mashriq* text does not contain any of these notations.

The Organ from Arabic Sources (The Hydraulis).

Then if you wish to make a sound¹³ let there be taken pedestals (*kursī*), and let them be placed around the apparatus. And let their elevation be to the place of the skins, in order that the skins may be placed on the pedestals. And let there be to them a width to the amount of the width of the couches (*sarīr*) in order that the men [who work the bellows] may stand upon them. And attach the [Greek]¹⁴ blast skins [? bellows] to their pipes [and they are the skins [? bellows] A B J D].¹⁵

Then they blow the skins until they are full of wind [and they are the skins Y and K].¹⁶ Then the wind enters [the receptacle] as far as the water, and it moves (*thāra*) it, and disturbs (*hāja*) it [from its level], and circulates, and goes round in it [the receptacle], and seeks the outlet. Then it escapes at the head of the receptacle with a loud, terrifying sound. It has strength and terror, and affrights (*lit. splits*) the hearts [of those who hear], and is heard the distance that we have mentioned.

And the men who blow will have their ears stuffed with cotton, and covered over with wax, in order that their senses may not depart and that they may not be injured in the ears.

And further to this there need not be only one sound [but there may be different sounds. I will mention them one by one, Please Allāh].¹⁷ And that is because there may be mounted upon the receptacle from which the wind goes out three or four pipes, upon each of which there is a sound-box (*sha'irat al-mizmār*). Then there will be produced other wonderful sounds.

¹³ The *Mashriq* text says "hear a sound."

¹⁴ Not in the *Mashriq* text.

¹⁵ Not in the *Mashriq* text.

¹⁶ Not in the *Mashriq* text.

¹⁷ This passage is not in the Brit. Mus. MS.

The Organ from Arabic Sources (The Hydraulis).

And likewise, if they intensify the blowing, the wind is strengthened, or if they diminish it, it is weakened.¹⁸ Then according to that, various kinds of sound are produced—pleasant, diverting, or otherwise. But the original purpose for which this apparatus was made is the carrying of the sound [to a distance].¹⁹ Then understand that, if Allāh wills.”

The author of this treatise clearly shows us an apparatus or cistern (*āla*) which is identical with the *bōmiskos* of Herōn and the *ar[c]a* of Vitruvius. In spite of the evidence of the design in the Bairūt manuscript, as given above, this cistern was not rectangular nor cylindrical, since its circumference is described as being broader at its base than at its summit, which is proper since the very word *bōmiskos* stands for “a wedge-shaped body.” It is described as having the form of an “oven” (*tannūr*), the Arabic word being identical with the Syriac.²⁰ The design in the British Museum MS. is more in accordance with the texts. At the same time, the receptacle (*unbūb* = *pnigeus*) appears to be more properly represented in the Bairūt design.¹

So far, the description of the Mūrīṣṭus instrument is quite clear. The author does not, however, actually tell us that the wind-pipes that conveyed the wind from the bellows passed through the apparatus (*āla* = *ar[c]a*) or cistern into the receptacle (*unbūb* = *pnigeus*). The Bairūt diagram rightly shows them passing into the receptacle, which agrees with Herōn and Vitruvius, but in the British Museum and Constantinople MSS. these pipes

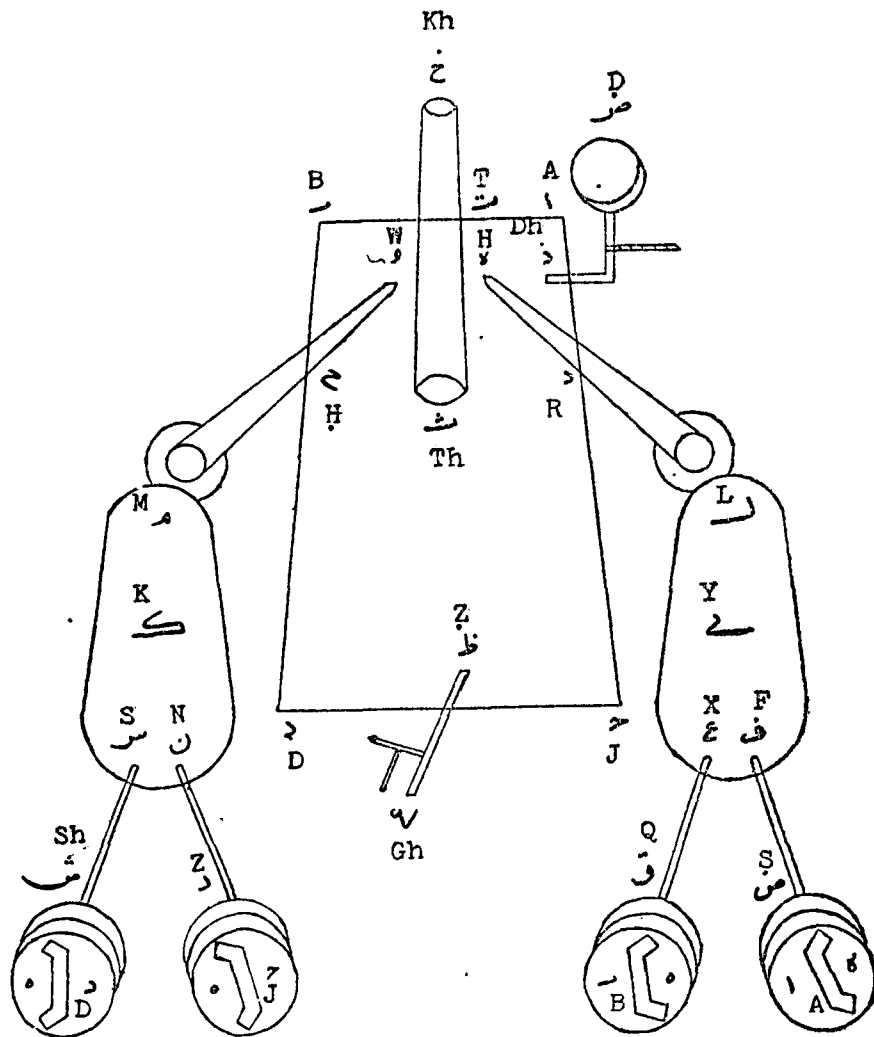


FIG. 13.—THE MURISTUS HYDRAULIS.

(*Al-urghīn al-būqī.*)

British Museum MS., Or. 9649.

¹⁸ This sentence has got mixed in the Brit. Mus. MS., so we follow the *Mashriq* text.

¹⁹ Not in the Brit. Mus. MS. ²⁰ See *ante*, p. 52.

¹ Cf. Vossius, 100.

The Organ from Arabic Sources (The Hydraulis).

have their ends in the apparatus. It was evidently the absence of this instruction from the text that led Baron Carra de Vaux to adopt a novel scheme for the hydraulic principle, which he committed to a design. This latter shows the wind-pipes from the bellows turned down immediately they enter the apparatus or cistern *without entering the receptacle or pnigeus*. The pipes enter the water and reach a point lower than the bottom of the receptacle or *pnigeus*, and are then turned upwards towards the inside of the receptacle or *pnigeus*. By this principle the wind is supposed to be forced through the water into the *pnigeus*. This design also shows a rectangular apparatus, which is quite opposed to the text, and its capacity is wrongly given as 9,000 *qisṭ* instead of 1,000.²

The method of the wind supply in the Mūristus instrument is rather anterior to the *hydraulis* that we know of from other sources. The bellows were the collapsible cylindrical bellows known to the Arabs as the *ziqq rāmī* or *ziqq zauqī*.³ There were six of these bellows, two for each of the three large skins in which the air was stored and compressed as in the modern weighted horizontal bellows.

Unfortunately we are told absolutely nothing of the principle of the sound-box (*sha'irat al-mizmār*), but as this instrument was furnished with flue-pipes, we know to some extent what the sound-box was like, although the term *sha'ira* may be rather puzzling.⁴ We do not even know the way in which the pipes were made to sound, whether by sliders, stoppers, or a key-action.

² Carra de Vaux, *L'Invention de l'hydraulis*, p. 334.

³ Cf. my *Studies in Oriental Musical Instruments*, p. 30.

⁴ See *ante*, p. 116.

The Organ of the Ancients.

The question of the Greeks using the *hydraulis* in their wars, as mentioned in the *Kitāb al-siyāsa* and the Mūristus treatise, is referred to by the Ikhwān al-Ṣafā' (tenth century). The "Brethren" were an association of philosophers of ultra-Shī'ī views, whose centre was at Al-Baṣra on the Euphrates. In discussing the influence of sound on the temperament of man, they say:

"The great, terrible sounds, out of proportion with one another, when they fall on the ears suddenly, corrupt the temperament, drive it from moderation, and cause violent death. And these [sounds] are found in an artificial instrument called the organ (*urghan*). And the Greeks (Yūnāniyūn) used to employ it in the wars, in order to terrify the souls of the enemy. And they stopped their own ears when they used it and played (*lit.* blew) it."⁵

Here we find the general term *organ* used, but undoubtedly it is the large *hydraulis* that is described. Elsewhere the "Brethren," speaking about musical instruments in general, refer to organs in the plural, as though they included several types of organs.⁶

We read of organs being employed in Western Europe in warfare, and perhaps the custom came from the East.⁷ Indeed, it has been suggested that the horn of Roland at Roncevalles was a *hydraulis*,⁸ and, strange to say, the instrument described in the *Kitāb al-siyāsa* was known in Latin literature as the *Horn of Alexander*.⁹

⁵ Ikhwān al-Ṣafā', i, 92.

⁶ *Ibid.*, i, 97.

⁷ The *hydraulis* in the Utrecht Psalter belongs to a military scene.

⁸ Wiedemann, *Byzantinische u. arabische akustische Instrumente*, 155.

⁹ Steele, *Roger Bacon's Secretum secretorum*.

The Organ from Arabic Sources (The Hydraulis).

It is also interesting to note the similarity of expressions 'twixt East and West regarding organs. In the well-known poem of Wulstan (d. 963) on the Winchester organ, we are told that "everyone stops with his hand his gaping ears, being in no wise able to draw near and bear the sound," whilst its nickname, "The Ruler of Thunder," reminds us of the Arabic name, "The Capacious Mouth with the Striking Voice."¹⁰ In his poem, *De Laudibus Virginum* Aldhelm (d. 709), describes an organ with a *thousand pipes*,¹¹ which reminds one of the *thousand notes* of the Hebrew *magrepha* and the *thousand voices* of the Syriac *urghanun*.

At what period the *hydraulis* ceased to interest the Arabs we do not know. That the Mūristus document at Bairūt dates from the twelfth century is certainly some sort of evidence, but, taken by itself, it may only mean that the Arabs were still interested in collecting books on music or on the sciences. At the same time, the testimony of Ibn Abī Uṣaibi'a that there were Arab organ constructors in the twelfth century, is not to be overlooked, and since organs were being constructed, one being presented to Khubilāi Khān,¹² it is quite certain that such a mechanical novelty as the *hydraulis* is almost certain to have found favour with the Arabs.

¹⁰ Migne, *Patr. Lat.*, cxxxvii, 110-11.

¹¹ Migne, *Patr. Lat.*, lxxxix, 240.

¹² See *ante*, p. 76, and *Studies in Oriental Musical Instruments*, p. 31.

CHAPTER VIII.

THE ARABIAN ORGAN IN EUROPE.

"Toute certitude qui n'est pas démonstration mathématique n'est qu'une extrême probabilité; il n'y a pas d'autre certitude historique."—Voltaire, *Dictionnaire Philosophique*.

HISTORIANS claim that the first organ known in Europe was introduced *by the Arabs*! This is stated in the *Histoire littéraire de la France* in the following terms:¹

"On sait que les premières orgues connues en France vers la fin du IX^e siècle passaient pour présent du Khalif Hārūn."²

The statement made by the authors of the *Histoire littéraire de la France* actually follows a description of a marvellous "organ" in the palace of the Saracen Amirs of Babylon which occurs in a twelfth century *chanson de geste* called *Aymeri de Narbonne*, written by Bertrand de Bar-sur-Aube. This "organ" was simply the "musical tree" which has already been referred to.^{2a} The learned editor of Bertrand's poem, L. Demaison, says that the

¹ *Hist. lit. de la France*, xxii, 467.

² To prevent confusion, I adopt *Hārūn*, the modern way of writing the name in English, instead of the various forms, *Aroun*, *Aaron* and *Haroun*, which are used in the works quoted here.

^{2a} See *ante*, p. 80.

The Arabian Organ in Europe.

author borrowed his notion of this "musical tree" from Constantinople, and shows that a Byzantine instrument is mentioned in the ninth century.^{2b} It is far more likely, however, that Bertrand borrowed his notion of this Saracen instrument from the Arabs of Spain, who were his neighbours, seeing that the Arabs also possessed the instrument in the tenth century.^{2c} Indeed, this *chanson*, like all the *chansons de geste* of the so-called Guillaume cycle, is based on local colour.

In Grove's *Dictionary of Music and Musicians* we have details of an organ said to have been presented by Khalif Hārūn early in the ninth century.³

"In 822 or 826 an organ was sent to Charlemagne by the Khalif Hārūn al-Rashid, constructed by an Arabian maker of the name of Ja'far,⁴ which was placed in a church at Aix-la-Chapelle. It was a pneumatic organ of extraordinarily soft tone."

When statements such as these are made in what are generally considered to be authoritative works, one naturally concludes that there must be substantial evidence for them. No authority is quoted in either of these works, and indeed the present writer has been unable to find any. Yet, in spite of the absence of authority, the story threatens to become established in our histories of music. The French account is given recognition in *Le grande dic-*

^{2b} Demaison, *Aymeri de Narbonne*, i, cli. Liutprand, *De rebus gestis*, vi, ii. See also *Annales archéologiques*, vii, 293-4: viii, 91: xxi, 313-14.

^{2c} See *ante*, p. 80. This "musical tree" is also introduced into Wolfram von Eschenbach's *Titurel* (twelfth-thirteenth century). See also the *Chanson du pèlerinage de Charlemagne* (*Romania*, ix, 11).

³ Grove (second edition), iii, 517. The third edition says, "Shortly after the year 800."

⁴ Ja'far = Giafar.

The Organ of the Ancients.

tionnaire of Larousse, and by Henri Quittard in *La grande encyclopédie*. In English works the story has passed through three editions of Hopkins and Rimbault's *The Organ, its History and Construction*, and three editions of Grove's *Dictionary of Music*. It has found an echo in the Smith-Cheetham *Dictionary of the Bible*, in Audsley's *Art of Organ Building*, and even in the Arabic journal, *Al-Mashriq* (ix, 20). In justice to all concerned, and to prevent fixity attaching itself to a statement of dubious origin, it seems advisable that the authenticity of these statements should be tested.

Search made in published historical documents has not revealed the authority. Western chroniclers certainly mention embassies passing between the French and the Arabian court at Baghdād, and presents being made. As early as the year 762, Pépin sent an envoy to Khalif Al-Manṣūr. He returned three years later, accompanied by an envoy from the Baghdād potentate. There were presents on both sides, but no organ is mentioned.⁵ More important were the Charlemagne-Hārūn missions.

In 797, Charlemagne dispatched an embassy to Khalif Hārūn, "the Persian king," as he is erroneously designated by the chroniclers. It arrived back at the French court in 801, attended by the Khalif's envoys, who brought "splendid gifts," including an elephant, but no organ is mentioned.⁶ In 802 another embassy set out for the Khalif's court from Charlemagne. It returned in 807, with envoys from the Khalif, among whom were two monks from Jerusalem named Georgius and Felix, the former being an abbot of a monastery on the Mount of

⁵ *Contin. de Frédégaire, Hist. Fr.*, v, 8.

⁶ *Mon. Germ. Hist.*, i, 190.

The Arabian Organ in Europe.

Olives. The Khalif's envoys were laden with presents for Charlemagne, including a magnificent tent, robes of silk, perfumes, balms, rare animals, and a wonderful clock which struck the hours.⁷ Yet there is still no mention of an organ.⁸ This mission is mentioned by several Western chroniclers, although we have not the slightest mention of any of these events in Arabic works. Indeed, the Western accounts are suspect in the eyes of some Orientalists.⁹

Since the documents fail us, we are compelled to work back from the *Histoire littéraire de la France* and Grove's *Dictionary*. In the first place, it is quite clear that organs were known in France long before the "end of the ninth century," as the *Histoire littéraire* states. The author of the passage in Grove's *Dictionary* was Dr. E. J. Hopkins, and he had previously collaborated with Dr. E. F. Rimbault in a work entitled *The Organ, its History and Construction*. In this latter work we have the following passage:¹⁰

"It also appears that an organ, constructed by an Arabian, named Ja'far, was sent to Charlemagne by the renowned 'Commander of the Faithful,' the Khalif Hārūn al-Rashīd—an incident introduced with considerable effect by Madame De Genlis, in her romance, *Les Chevaliers du Cygne*. This was the instrument, in all pro-

⁷ *Mon. Germ. Hist.*, i, 194.

⁸ Clément Huart, *Histoire des Arabes*, ii, 107, includes "instruments de musique" among the presents. There is no foundation for the statement. Perhaps this writer was misled by the account of the clock which sounded the hours on a bell (*cymbalum*). Heyd, *Hist. du Commerce du Levant*, i, 90, has a similar statement.

⁹ *Der Islām*, iii, 409, iv, 333. *Ency. of Islām*, ii, 271.

¹⁰ Hopkins-Rimbault, 14.

The Organ of the Ancients.

bability, which Walafrid Strabo described as existing in the ninth century in a church at Aix-la-Chapelle."

Comparing this passage with the account given in Grove's *Dictionary*, it is obvious that Hopkins, the author, was partly repeating what had been written in the Hopkins-Rimbault book. At the same time it will be noticed that there is a wide difference between the two in another respect. In the Hopkins-Rimbault book we have such phrases as "it also appears" and "in all probability." In Grove's *Dictionary* these appearances and probabilities become transformed into actual historical events, whilst the De Genlis reference is ignored, and the instrument is gratuitously stated to be a pneumatic organ.

Among the additions of Hopkins to the Hopkins-Rimbault narrative are the dates for the presumed Hārūn present of the organ to Charlemagne. Two are given, "822 or 826." These dates were evidently derived from Seidel's book on *The Organ and its Construction*.¹¹ We cannot trace where Seidel got the first of these dates from, unless it is a slip for 802, when the presents of the first embassy *actually arrived* at Aix-la-Chapelle. The year 826¹² is the date when Louis le Débonnaire had an *hydraulis* (*organum hydraulicum*) constructed for himself by Georgius Veneticus. On the other hand, Seidel and Hopkins say that the instrument was a *pneumatic organ*, which shows that they had in mind the organ made for Charlemagne at the time of the Byzantine embassy in

¹¹ *The Organ and its Construction* (1855), p. 15. There were two English translations (1852 and 1855) of Seidel's *Die Orgel und ihr bau*.

¹² The chroniclers give two dates—826 and 828. This may partly account for Hopkins's two dates.

The Arabian Organ in Europe.

812.¹³ At any rate, both the dates of Seidel and Hopkins are too late, since Hārūn died in 809, and Charlemagne in 814.

Prima facie, the Grove's *Dictionary* account is based on the Hopkins-Rimbault narrative, but what was the latter's source of information? Was it any other than De Genlis? Anyone reading the "Notes" with which Madame De Genlis furnished her work, is almost bound to conclude that this was the source of information, or else, that both De Genlis and Hopkins-Rimbault borrowed from a common source.

In her chapter on the "Origin of the Organ," Madame De Genlis introduces us to a certain Ja'far (Giafar), who is made out to be, for the sake of the story, a European born in Persia. This Ja'far, and his three brothers, who were all musicians, came to Baghdād, and, being Christians, they met each Sunday in worship to the accompaniment of musical instruments. The Khalif, however had forbidden Christians to worship in this manner, and the prohibition led Ja'far to seek for some device whereby he might evade the Khalif's edict, and then De Genlis makes Ja'far speak thus:¹⁴

"I had a strong mechanical turn; and, after some reflection, I conceived the idea of contriving an instrument, which would imitate those already known, and even the human voice. At the same time, I wanted it to produce a sound that resembled a concert of various tones. I applied myself night and day, and, in less than six

¹³ *Mon. Germ. Hist.*, ii, 751. It is worth noting that this Byzantine embassy was at Charlemagne's court at the same time (812) as an embassy from the Khalif was there. It looks as though the second embassy from the East had a long stay.

¹⁴ De Genlis, ii, 133.

The Arabian Organ in Europe.

months, formed an instrument of enormous bulk, which I named an *organ*."

Of the later history of this organ we are informed in the words of Ja'far as follows:¹⁵

"He [the Khalif] disposed . . . of my organ in a manner which highly gratified me. The ambassadors of Charlemagne were then at his court; and the Khalif included the instrument in the number of the presents with which he charged them for their master."

In her Notes to this chapter (xiv) De Genlis says:

"It is known that the first organ which was seen in Europe was sent to Charlemagne by the Khalif Hārūn [Aaron]. I have only superadded the origin of that instrument, which is entirely unknown to us."

Our author distinctly says that the story of the first organ in Europe being a gift from Hārūn was *already known*! That sentence and the one in the *Histoire littéraire de la France* are so perilously akin, that the former appears suspiciously like its authority. It is certainly not a commonplace in French history, and although it appears in both Forkel¹⁶ and Mendel,¹⁷ they both quote De Genlis.

Of course, De Genlis says that her account of the origin of the organ "is entirely unknown to us." Did she mean by this that she was tapping a hitherto unknown source of information, or is it to be implied that the story was chimerical, imaginary? One thing is quite certain, and that is that the organ of Ja'far, as described by Madame De Genlis, was unheard of in the ninth century. It is represented as being something like a bureau that could be opened or shut, and played by one person who

¹⁵ *Ibid.*, ii, 137. ¹⁶ Forkel, *Allgem. Gesch. d. Musik*, ii, 359.

¹⁷ Mendel, *Musik Kon. Lex.*,

The Organ of the Ancients.

sat in front of the instrument.¹⁸ The author evidently had in mind (in spite of the "enormous bulk" in her description of the instrument) a type similar to the large *regal* of comparatively modern times.

The upshot of this inquiry is that the statement in Grove's *Dictionary* is to be traced apparently through Hopkins-Rimbault and the *Histoire littéraire de la France* to De Genlis.

Strange to say, however, there does appear to be a well evidenced claim for the Arabian influence in the introduction or reintroduction of the *hydraulis* into Western Europe, which has not been recognised hitherto. The credit of having introduced or reintroduced the *organ* into Western Europe belongs to the Byzantine Emperor Constantine Copronymus, who, we know, presented an instrument of this sort to King P'epin in 757.¹⁹ Whether the pneumatic organ ever actually disappeared in the Dark Ages or not,²⁰ we may assume with some degree of certainty that it fell into desuetude only in the West but not in the East. Not so the more complex and anathematised *hydraulis*, which, we may take for granted, ceased to exist after the fifth century in both the East and West through causes already specified.¹

The *hydraulis* does not reappear in the West until the opening of the ninth century when several Latin chroniclers tell us under the year 826 (or 828) that a certain presbyter, Georgius Veneticus, constructed an instrument of

¹⁸ De Genlis, ii, 135.

¹⁹ *Mon. Germ. Hist.*, i, 28, 29, 74, 140, 347, v. 99, 547.

²⁰ Cf. Gevaert, *Mélopée antique*, 416.

¹ See *ante*, p. 50, also 25, 43, 48. See my *Historical Facts for the Arabian Musical Influence*, 295-7.

The Arabian Organ in Europe.

this type for Louis le Débonnaire.² This reference to the *hydraulis* is the first in the West since the time of Apollinaris Sidonius (c. 483), and in the East since Isaac of Antioch (fl. 459) and the *Talmud* (c. 500). In the claims for the reintroduction of the *hydraulis* into the West, we can consider three distinct media—the Occidental, the Byzantine and the Arabian or Syro-Arabian.

The Occidental claim is based on the assumption that the *hydraulis* never really fell into disuse. It was put forward by J. F. Rowbotham, the brilliant and learned, though not wholly reliable, historian of music. He firmly believed that Georgius of Venice brought the art of organ construction in general to France from Italy, where it had subsisted since classical times.³ If it be true that in 826

² *Mon. Germ. Hist.*, i, 359. "Georgius quidam presbyter de Venetia, cum Baldrico comite Foroiulienne veniens, organum ydraulicum Aquisgrani fecit." xv, 280. "Hic est Georgius Veneticus, qui de patria sua ad imperatorem venit et in Aquense palatio organum, quod græce hydraulica vocatur, mirifica arte composuit." Here the date is given as 828.

³ Rowbotham, iii, 259, 261-2, 395. Of course we have the statement that the (pneumatic) organ was introduced into the Church by Pope Vitalian (c. 660), (*Joannes Diaconis Vita S. Gregorii*), but this has been rejected. Buhle, 61. The Roman singers, Theodore and Bennet, who entered France c. 787, are said to have taught *organ playing* to the French. *Mon. Germ. Hist.*, i, 170. Even this event is suspect. The use of the word "organ" (*organum*, *organa*) by mediæval writers still implies in many instances a general term for "a musical instrument." Isidore (ii, 20) says: "Organum vocabulum generale." Amalarius (*De eccles. off.*, iii, 3) says: "Organum vocabulum est generale vasorum omnium musicorum." Papias (*Vocab.*) says: "Organum generale nomen."

The word *organa* (plur.) in Fortunatus (*Carmina*, ii, 9) bears this reading, and similarly that in Amalarius (*De eccles. off.*, iii, 2), although when the latter wrote (ninth century) the pneumatic organ was already known in France. As for Aldhelm, his reference to the organ in his *Riddles* certainly applies to "a musical instrument," which is the general Anglo-Saxon connotation of the word. (See *Archiv. für das Studium der Neueren Sprachen*, xcvi, 32; *Bibl. der Angelsächsischen Prosa*, iii, 136.) In *De laudibus*

The Organ of the Ancients.

(828), Italy was still the "home of organ building," as Rowbotham says, it is certainly strange that half a century later, Pope John VIII (872-82) should be constrained to appeal to Bishop Anno in Germany saying: "Send me the best organ that you can obtain, together with a player [?], as we have none here."⁴

Another well known writer, who holds a brief for Italy, says: "Venice seems to have been famed for its organ builders during the ninth century, for Louis le Débonnaire sent there, it is recorded, for a certain monk, Georgius Benevento, to construct a hydraulic organ for his palace at Aix-la-Chapelle."⁵ It is *not* recorded that Louis *sent* to Venice for Georgius. All that we are told is that he *came* in the suite of Count Baldric. Further, his name was not Georgius Benevento, but Georgius Veneticus.

This Georgius Veneticus constructed an *hydraulis* for Louis le Débonnaire, and we read that the king gave instructions for the necessary materials to be supplied.⁶ Coupled with this we have the claim that Eginhard (d. c. 840), who was the biographer of Charlemagne and Louis le Débonnaire, and Minister of Public Works, preserved for posterity, the famous book, *De architectura*, of Vitruvius, which contains the only Latin description of the *hydraulis* and its construction in the Middle Ages.⁷

These facts, placed side by side, would rather appear to enhance the Occidental claim for the reintroduction of the *hydraulis*, at least circumstantially. In reality, however,

virginum of Aldhelm, the organ described is probably a phantasy prompted by the Church Fathers. (See *ante*, p. 138, and Wiener, *Contributions towards a History of Arabico-Gothic Culture*, i, 18.)

⁴ Baluze, *Miscellanea*, v, 490. ⁵ Schlesinger, *The Organ*, 267.

⁶ *Mon. Germ. Hist.*, i, 214.

⁷ Teulet, *Œuvres complètes d'Eginhard*, ii, 46.

The Arabian Organ in Europe.

the Vitruvius reference contributes no evidence, for this reason. Whatever guidance the presbyter Georgius Veneticus may have had in constructing his *hydraulis*, it was certainly not from the book of Vitruvius, even though we may have a copy dating from this very century. In spite of Seidel's opinion to the contrary,⁸ the work of Vitruvius as we know it, contains no diagrams, and, above all else, it tells us absolutely nothing about the hydraulic principle, the most essential factor of all.⁹ Indeed, many scholars, some of whom have had Herōn's more detailed work to refer to, have been baffled about the hydraulic principle of the instrument for four hundred years.¹⁰

The Byzantine claim for the reintroduction of the *hydraulis* is based on a rather doubtful assumption that artist craftsmen, "Greeks of the Christian East," "were dispatched to various parts of Europe to instal the hydraulic and the pneumatic organ in palaces, theatres, churches and amphitheatres."¹¹ I am not aware that there is any authority for so wide a statement. That the Byzantine Emperor Constantine Copronymus sent the French King Pépin an *organ* in 757, and that Charlemagne had another made after a Byzantine model in 812, may readily be allowed. But that is not evidence of Byzantine craftsmen being sent to "various parts of Europe" to instal organs in palaces, theatres, churches and amphitheatres.

As for the *hydraulis* built for Louis le Débonnaire in

⁸ Seidel, *The Organ and its Construction*, 14.

⁹ Brit. Mus. MS., Harl. 2767, fol. 150 *et seq.*

¹⁰ For a scholarly survey of this question see Maclean.

¹¹ Schlesinger, *Is European Musical Theory Indebted to the Arabs?*, 15.

The Organ of the Ancients.

826 (828), there is no mention of Byzantine craftsmen.¹² What is actually stated is that Georgius Veneticus himself constructed the instrument *after the Greek manner*,¹³ which does not necessarily mean that the model was borrowed immediately from the Byzantines, but that the *hydraulis* was an instrument invented and given its name by the Greeks.¹⁴ That Georgius borrowed from an existing Byzantine model does not even square with history since we cannot trace any mention of the *hydraulis* among the Byzantines during the sixth, seventh and eighth centuries.¹⁵ a period which coincides with a similar gap in Western Europe.

The evidence for the Arabian claim for the reintroduction of the *hydraulis*, is not to be sought in the doubtful material that we have already had under consideration, *but in Arabic sources*. In the Arabic treatise on the construction of the *hydraulis*, attributed to Mürîşî, it is positively stated that the translator or adaptor (scarcely the author) had constructed an *hydraulis* for the "King of the Inner Franks."¹⁶ This MS. was copied in the twelfth century, but we can be certain that the work was known in the tenth century, and possibly in the ninth century, or even the eighth century, as we have already indicated.¹⁷

It must be recognised that the revival of the *hydraulis* synchronises with the revival of the arts and sciences of antiquity by the Arabs. Further, we cannot ignore the fact that many if not most of these arts and sciences fil-

¹² Cf. *Mon. Germ. Hist.*, ii, 513.

¹³ *Mon. Germ. Hist.*, ii, 629. "Qui se promitteret organum more posse componere Græcorum."

¹⁴ *Mon. Germ. Hist.*, xv, 260. "Quod Græce hydraulica vocatur."

¹⁵ Gastoué, 571-2. ¹⁶ See *ante*, p. 128. ¹⁷ See *ante*, pp. 60, 127.

The Arabian Organ in Europe.

tered into Europe via the Arabian culture-contact, and we have definite clues that Arabian musical instruments and practices were finding their way into Europe at this time.¹⁸

Among the sciences which are intimately connected with the *hydraulis* are hydrostatics and pneumatics, and seeing that both Philōn and Herōn were translated from Greek into Arabic, and then *from Arabic into Latin*, it is not perhaps too much to assume that a work or works on the construction of the *hydraulis* may also have been translated from Arabic into Latin. Indeed, Kircher, who deals with several instruments of these types, may have had documents rather than actual specimens as his authority.

As to the identity of the "King of the Inner Franks" for whom the author (but more probably the compiler) of the Mürîşî treatise made a *hydraulis*, Hartwig Derenbourg, commenting on the opinion of Père Cheikho,¹⁹ says that it was the Frankish king Pépin.²⁰ The instrument, however, that was presented by the Byzantine emperor to Pépin in 757 is generally supposed to have been a pneumatic organ, although we have no definite indication that it was such an instrument.

The term "Inner Franks" (*Afranjat al-dākhila*) means the Franks furthest away from the borders of the Khalifate. We find a similar expression being used by Al-Qazwīnī who refers to the "Inner Byzantines" (*bāṭin al-Rūm*) in the same sense.¹ Professor Dr. Wiedemann was

¹⁸ On the whole question see my *Arabian Influence on Musical Theory* (1925) and *Historical Facts for the Arabian Musical Influence* (1930).

¹⁹ *Mashriq*, ix.

²⁰ *Revue Musicale*, 6e année, Nos. 8-9, p. 193.

¹ Al-Qazwīnī, ii, 410. See also Jacob, *Ein arabischer Berichtstatter aus dem 10. Jahrhundert* (Berlin, 1891), p. 14, and Al-Maqqārī, *Moh. Dyn.*, i, 511, and Appendix xliii.

The Organ of the Ancients.

of opinion that if one of the German emperors were intended it must have been one of the Carolingian or Saxon emperors.² It has also been suggested, as we have seen, that the Horn of Roland at Roncevalles was a *hydraulis*,³ and colour is lent to the suggestion by reason of the *hydraulis* being actually known as the "Horn of Alexander the Great."⁴

It is also not improbable that Georgius Veneticus, who constructed the 826 (828) *hydraulis*, may have learned about the instrument from Arabian or Syro-Arabian constructors. It happens that Georgius was the name of one of the envoys that came with Khalif Hārūn's embassy to Charlemagne in 807, carrying presents for the Frankish emperor. He was a monk of Jerusalem, which for two centuries had been in Arab hands. Some of the Khalif's envoys appear to have stayed at Charlemagne's court for a considerable time, since we read of their presence there in 812.⁵ Perhaps Georgius was one of the original envoys of 807, but being a Frank by nationality,⁶ he may have been desirous of staying in the West,⁷ and may have settled at Venice. If so, this may be the same Georgius, now surnamed Veneticus, who came with Count Baldric of the Marches of Pannonia, to the court of Charlemagne in 826 (828) promising to construct an *hydraulis*. Venice was in political and commercial contact with both Syria and

² Wiedemann, *Byz. u. arab. akustische Instrumente*, 155.

³ *Ibid.* ⁴ Steele, *Roger Bacon's Secretum Secretorum*.

⁵ The Frankish envoys stayed for about three years in Baghdād.

⁶ Pompeo Molmenti, *Venice. The Middle Ages*, ii, 162, says that this Georgius came from the island of S. Georgio in Alga [sic]. I do not know the authority for this statement.

⁷ After the rebellion of 746, when Marwān razed the walls of Jerusalem, it is probable that the relations between Muslims and Christians were strained.

The Arabian Organ in Europe.

Egypt at this time, and it was the most important European port for the Levantine trade. Here, the services of Georgius Monachus of Jerusalem, who was *au fait* with the languages and customs of the peoples of the Khalifate, would be invaluable.⁸ At any rate, Georgius Veneticus was afterwards given the post of abbé of the monastery of S. Sauve le Martyr in Valenciennes.⁹

Whether we grant that the "King of the Inner Franks" was Pépin, or recognise the identity of the two Georges or not, it still remains fairly certain that the ninth century *hydraulis* of Western Europe came from the Orient. Amédée Gastoué, the historian of Byzantine music, says that whilst the small portatives were introduced into the Occident by Byzantine envoys to Charlemagne's court, it appears that "the makers of the first large organs [positives] in the Occident in the ninth century, were, without doubt, either Greeks or Syrians."¹⁰ Since Gastoué gives his opinions elsewhere that the *hydraulis* had died out by this time amongst the Greeks,¹¹ the greater probability rests with the Syrians. Yet the Syrians were only prompted to this work by reason of the Arabian culture movement. Until the days of Islām, the Syrians showed scarcely any interest in the arts and sciences.¹²

In Byzantium, the idea of a *hydraulic pressure stabiliser* as in the *hydraulis*, had been superseded by the barystathmic principle of the weighted blast-bag. In the face of this there seems to be no reason why a return to the old system should have been made by them without some external prompting. On the other hand the Arabs did not

⁸ Heyd, *Hist. du Commerce du Levant*, i, 94, 109.

⁹ Teulet, *op. cit.*, ii, 228. ¹⁰ Gastoué, 546. ¹¹ Gastoué, 571-2.

¹² Farmer, *Historical Facts for the Arabian Musical Influence*, p. 130.

The Organ of the Ancients.

possess any type of organ, at any rate not the *hydraulis*, until the Syro-Arabian school of translators revealed the treatises on organ construction written by the Greeks of old. When, at the close of the eighth or beginning of the ninth century, the Arabs began to build the *hydraulis*, after the manner of the Ancients, it is highly probable that the Byzantines, who had discarded the instrument some centuries before, and had lost all knowledge of its actual construction, readily adopted the *hydraulis* anew under the impulse of the Arabian culture movement.

The artistic, literary and scientific impetus given to Byzantium by this movement at the beginning of the ninth century, is well attested. We see it in architecture,¹³ and in the industrial arts most markedly.¹⁴ That scientific and classical studies began to be revived in Byzantium precisely at this period, is strangely coincident.¹⁵ The evidence of the *Utrecht Psalter*, which especially concerns our subject, is not inconsiderable. This production is said to date from the ninth century, and from the testimony of the palæographers and other experts, we are led to conclude that the designs reveal Oriental influences, probably Syrian, or perhaps Byzantine under Syro-Arabian urge.¹⁶ It is in the *Utrecht Psalter* that we get our first pictorial representation of the *hydraulis* in the Middle Ages.

¹³ *Cambridge Mediæval History*, iv, 39. Bury, *Hist. of the Eastern Roman Empire*, 436.

¹⁴ Bury, op. cit., 433. Diehl, *Manuel D'Art byzantin*, 369, 643.

¹⁵ Gibbon (Bury edit.), vi, 104. Omont, *Facsimiles des plus anciens MSS. grecs du IX au XIX siècle*.

¹⁶ "I consider that the musical instruments [in the *Utrecht Psalter*] bear distinct traces of Oriental influence such as the Greeks of Asia Minor, Syria and Northern Egypt would be likely to have felt in their intercourse with the Persians, Arabs, etc." Kathleen Schlesinger, *Precursors*, 344. Italics mine.

The Arabian Organ in Europe.

A final word concerning the later history of the *hydraulis* may not be out of place here. Dr. Maclean says: "Water organs [i.e., *hydraules*] hardly existed after the ninth century." Further, the year 850 is assumed by him as the date when they died out.¹⁷ I believe that it can be demonstrated that the *hydraulis* existed at a much later date.¹⁸ It is certainly mentioned by Isho' bar 'Ali (ninth century),¹⁹ Aurelianus Reomensis (fl. 890),²⁰ Hucbald (d. c. 930), or Pseudo-Hucbald,¹ Bar Saroshwai (tenth century),² Isho' bar Bahlul (fl. 963),³ Elias bar Shinaya (b. 975),⁴ the Ikhwān al-Ṣafā' [?] (tenth century),⁵ and Gerbert (d. 1003).⁶ Possibly, the instrument cannot be traced later than Jerome of Moravia (thirteenth century),⁷ and the opinion of Warman that it existed until the seventeenth century,⁸ is probably due to his confusing the *hydraulis* with other hydraulic organs of the "air compressor" type.⁹

Gerbert, who later became Pope Silvester II, is claimed to have studied under Arabian masters. Certainly, he was deeply influenced by Arabian learning, and is credited with having introduced several "Arabian sciences" into Europe, including the Arabic numerals.¹⁰ He was highly skilled in music and was probably "beyond his age in

¹⁷ Maclean, 192, 213.

¹⁸ It must be admitted, however, that most of the *data*, being from eastern sources, were unknown to Dr. Maclean.

¹⁹ Payne Smith, 977-8.

²⁰ Gerbert, *Script.*, i, 33.

¹ Gerbert, *Script.*, i, 109.

² Payne Smith, loc. cit.

³ Payne Smith, loc. cit.

⁴ Payne Smith, loc. cit.

⁵ Ikhwān al-Ṣafā', i, 92.

⁶ Migne, *Patr. Lat.*, clxxix, 1140.

⁷ Coussemaker, *Script.*, i, 5.

⁸ Warman, 44.

⁹ Kircher, ii, 308.

¹⁰ For a fuller discussion of Gerbert in relation to the Arabian culture movement, see my *Historical Facts for the Arabian Musical Influence*, pp. 177-86, and Appendix 13.

The Organ of the Ancients.

this science,"¹¹ seeing that both France and Italy were in a parlous state in this respect.¹² In his letters there are many references to the organ, and he is said to have constructed an *hydraulis* whilst he was at Rheims about the year 976, and certainly before 980.

The description of this *hydraulis* by William of Malmesbury in his *Gesta rerum Anglorum* has given rise to quite a crop of misconceptions. Here is the passage together with a fresh translation which probably gives a correct explication of the much contorted phrase *per aquae calefactae violentiam*:

"Extant apud illam ecclesiam doctrinae ipsius documenta: horologium arte mechanica compositum; organa hydraulica, ubi mirum in modum, per aquae calefactae violentiam, ventus emergens implet concavitatem barbiti, et per multiforatiles tractus aereae fistulae modulatos clamores emittunt."

It was the phrase, "*per aquae calefactae violentiam*," that gave rise to the fables in our histories about the "steam organ."¹³ *Calefacio*, in its figurative sense, means "to disturb, excite," so as to give power. Water disturbed from its level in the *ar[c]a* of the *hydraulis*, becomes a static force.

¹¹ *Ency. Brit.*, xxv, 118.

¹² Richer, iii, 44, 49.

¹³ *Gesta reg. Angl.* (T. D. Hardy Edition, 1840), i, 276. Maclean, 212. It must be always borne in mind, however, that the Gerbert instrument might have been a "steam organ" of the Herōn type. See Herōn's *Pneumatics*, Sect. 75.

The Arabian Organ in Europe.

From whence did Gerbert derive his "invention"? It is highly probable that the Arab Umayyads of Al-Andalus had *klepsydras* from an early date (see *ante*, p. 80). Toledo had a famous water-clock (*bankām*) designed by Al-Zarkālī in the eleventh century. (Al-Maqqarī, *Moh. Dyn.*, i, 81-3, 385). It has already been shown that the organ was probably known to the Arabs of Spain.¹⁴ The poet Ibn Ḥazm (d. 1064) speaks of it among a number of Arab musical instruments:¹⁵

"And the *duff*, the *ṭunbūr*, and the *mizmār*,
Likewise the *urghān* and the *rabāba*,
And the *nāy*, the *maṣṣūl*, and the *shabbāba*."

At the same time it ought to be pointed out that the conclusions adopted by M. Soriano-Fuertes on this question are certainly unwarrantable. He has stated that the *mizmār* was an *hydraulic organ*, and that the *shāhrūd* was a *clavier-organ*.¹⁶ His sources, Al-Fārābī and Al-Shalāhī (= *Kitāb al-imtā'*) do not contain any statements that warrant such affirmations being made.

What ultimately contributed to the disuse of the *hydraulis* in Western Europe was precisely the same factor that had led to its supersession after the fifth century, that is to say, the improvement in the weighted blast-bag of the *pneumatic organ*, which provided a more convenient force of stabilisation of the wind pressure, than that involved in the *hydraulis*.¹⁷

¹⁴ See *ante*, p. 76.

¹⁵ *Safinat al-mulk* (Cairo, A.H. 1309), p. 473.

¹⁶ *Música Árabe-Española* (Barcelona, 1853), pp. 34-5. Cf. 54-5. He erroneously writes *mizamir* and *xamerud*.

¹⁷ Maclean, 192. The year 650 is given as the approximate date for the adoption of the weighted blast-bag. We do not know the authority for positing this date, but the evidence of the Obelisk of Theodosius (d. 393) almost compels an earlier one.

The Organ of the Ancients.

APPENDIX I.

SCALE OF ARABIC MEASUREMENTS USED IN THE PRESENT WORK.

1 Digit = 1 <i>iṣba'</i> or ' <i>aqd</i> '	2.25 cm.
1 Shut Digit = 1 <i>iṣba' maḍmūm</i>	4.5 cm.
1 Open Digit = 1 <i>iṣba' maftūh</i>	6.75 cm.
1 Span = 1 <i>shibr</i>	27 cm.
1 Cubit = 1 <i>dhirā'</i> (= 1 Hebrew <i>ammah</i>) ...	54 cm.

¹ According to Baron Carra de Vaux (*Journal Asiatique*, Mars-Av., 1891, p. 319) an '*aqd*' is a smaller measure than an '*iṣba'*'. See also *Der Islām*, viii (1918), p. 56.

APPENDIX II.

HERŌN'S *HYDRAULIS*.

HERŌN'S *Mechanics* has come down to us in an Arabic version practically complete, whilst only fragments of the original Greek have been preserved. Unfortunately for our present studies, the *Pneumatics* has only survived in Greek, although we know that it existed in Arabic. As Herōn's *hydraulis* is much later than the instrument described in the Arabic Mūristus treatise, it is essential perhaps that Herōn's description should be included here.

The translation is that made by J. G. Greenwood, Professor of Greek and Latin at Owen's College, Manchester, and Bennet Woodcroft, Professor of Machinery in the University College, London.¹ Other translations have been made both before and since, but this translation is just as suitable for the present purpose as a fresh translation based on the textual emendations of Schmidt² would be. Here and there, however, slight changes have

¹ Woodcroft, B., *The Pneumatics of Hero of Alexandria. From the Original Greek.* London, 1851.

² *Herons von Alexandria Druckwerke und Automatentheater Griechisch u. Deutsch Herausgegeben von W. Schmidt.* Leipzig, 1899.

The Organ of the Ancients.

been made in the terms used, but in each case the original words of Greenwood and Woodcroft are given in the footnotes.

Herōn describes how the cylindrical pumps of this *hydraulis*, instead of being worked by hand, may be worked by a wind-mill. The Banū Mūsā also devise the wind-mill among their automatic appliances for working their "organ."

"THE CONSTRUCTION OF AN HYDRAULIS (ORGANON HYDRAULIKON)."

"Let $A B C D$ be a cistern (*bōmiskos*)³ of bronze containing water. In the water invert a hollow hemisphere, called a *pnigeus*, $E F G H$, which will allow of the passage of the water at the bottom. From the top of this let two tubes ascend above the cistern; one of them, $G K L M$, bent without the cistern and communicating with a cylinder,⁴ $N X O P$, inverted, and having its inner surface made perfectly level to fit a piston. Into this cylinder let the piston $R S$ be accurately fitted, that no air may enter by its side; and to the piston attach a rod, $T U$, of great strength. Again, attach to the piston rod another rod, $U Q$, moving about a pin at U , and also working like the beam of a lever on the upright rod $W Y$, which must be well secured. On the inverted bottom of the cylinder $N X O P$ let another smaller cylinder Z , rest, communicating with $N X O P$ and closed by a lid above: in the lid is a hole through which the air will enter the cylinder. Place a thin plate under the hole in the lid to close it, upheld by means of four pins passing

³ "Small altar."

⁴ "Box."
160

Appendix II.

through holes in the plate, and furnished with heads so that the plate cannot fall off: such a plate is called a valve.

"Again, let another tube, $F I$, ascend from $F G$, communicating with a transverse wind-chest⁵ $J V$, on which rest the organ-pipes⁶ (*auloi*) $a a a$, communicating with the transverse wind-chest, and having at the lower extremities small boxes (*glōssokoma*) . . . ; these boxes communicate with the organ-pipes, and their orifices $b b b$, must be open. Across these orifices let perforated sliders⁷ move, so that, when the sliders are pushed home, the holes in them coincide with the holes in the organ-pipes, but, when the sliders are drawn outwards, the connection is broken and the organ-pipes are closed.

"Now, if the transverse beam $U Q$ be depressed at Q , the piston $R S$ will rise and force out the air in the cylinder $N X O P$; the air will close the aperture in the small cylinder Z by means of the valve described above, and pass along the tube $M L K G$ into the hemisphere: again it will pass out of the hemisphere along the tube $F I$ into the transverse wind-chest $J V$, and out of the transverse wind-chest into the organ-pipes, if the apertures in the organ-pipes and the sliders coincide, that is, if the sliders, either all, or some of them, have been pushed home.

"In order that, when we wish any of the organ-pipes to sound, the corresponding holes may be opened, and closed again when we wish the sound to cease, we may employ the following contrivance. Imagine one of the boxes at the extremities of the organ-pipe, $c d$, to be isolated, d being its orifice, e the communicating organ-

⁵ "Tube."

⁶ "Pipes."
161

⁷ "Lids,"
12

The Organ of the Ancients.

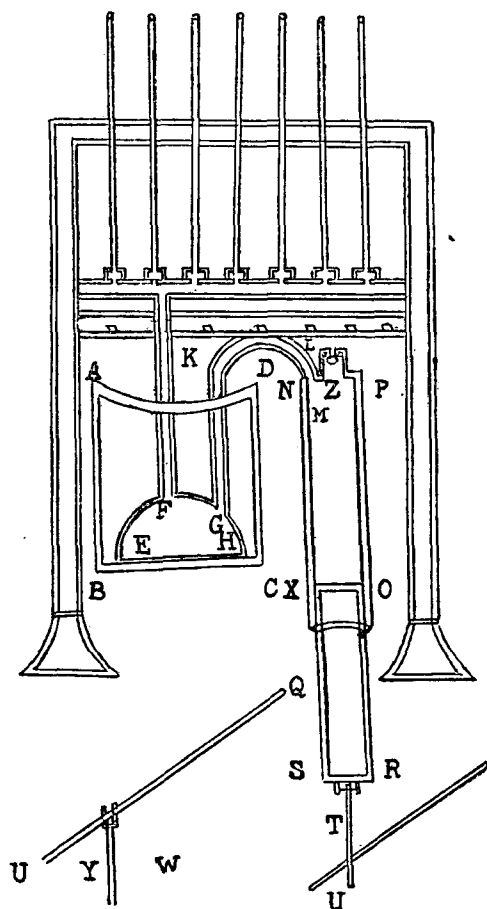


FIG. 14.—THE HERON HYDRAULIS.

Brit. Mus. MS., Harl. 5589.

pipe, *r s* the slider fitted to it, and *g* the hole in the slider not coinciding with the organ-pipe *e*. Take three jointed bars *f h*, *h m*, *m o*, of which the bar *f h* is attached to the slider *s f*, while the whole moves about a pin at *n*.

162

Appendix II.

Now, if we depress, with the hand, the extremity *o* towards *d*, the orifice of the box, we shall push the slider inwards, and, when it is in, the aperture in it will coincide with that in the organ-pipe.⁸ That, when we withdraw the hand the slider may be spontaneously drawn out and close the communication, the following means may be employed. Underneath the boxes let a rod, *p q*, run, equal and parallel to the transverse wind-chest *j v*, and fix to this slips of horn, elastic and curved, of which *r*, lying opposite *c d*, is one. A string fastened to the extremity of the slip of horn, is carried round the extremity *h*, so that, when the slider is pushed out, the string is tightened; if, therefore, we depress the extremity *o* and drive the slider inwards, the string will forcibly pull the piece of horn and straighten it, but, when the hand is withdrawn, the horn will return again to its original position and draw away the slider from the orifice, so as to destroy the correspondence between the holes. This contrivance having been applied to the box of each pipe, when we require any of the organ-pipes to sound we must depress the corresponding key with the fingers; and when we require any of the sounds to cease, remove the fingers, whereupon the sliders will be drawn out and the organ-pipes will cease to sound.

"The water is poured into the cistern that the superabundant air (I mean, of course, that which is thrust out of the cylinder and forces the water upwards), may be confined in the hemisphere, so that the organ-pipes which are free to sound may always have a supply. The piston *R S*, when raised, drives the air out of the cylinder into the hemisphere, as has been explained; and when de-

⁸ "Tube."

The Organ of the Ancients.

pressed, opens the valve in the small cylinder *Z*. By this means the cylinder is filled with air from without, which the piston, when forced up again, will again drive into the hemisphere. It would be better that the rod *T U* should move about a pivot at *T* also, by means of a loop⁹ *R*, which may be fitted into the bottom of the piston, and through which the pivot must pass, that the piston may not be drawn aside, but rise and fall vertically."

⁹ "Single [loop,]"

The Organ of the Ancients.

So let there be a 'feeder' $V X Y R$, five palms in height, and three and a half palms in width, with diaphragms perforated in the form of a sieve, and provided with two pipes, of which the larger, $T S$, will supply fresh water with a stop cock (*epistomium*) at T for stopping the flow when required. This pipe will be diverted within the vessel (= 'feeder'). Above this vessel there is another pipe, $V Z$, which conveys the wind blast to the 'wind-chest,' i.e., into the *anemotheca*, of the organ. The water, rushing through the pipe $T S$ with great force into the vessel (= 'feeder') at R , puts in constant motion not only the wind already there, but other wind generated afresh. And the air, compelled by the density of the moisture, seeking expansion through the perforated or carded diaphragms, and unable to find it, will escape through $V Z$ into the 'wind-chest.'

"Further, the water, escaping with great force through the opening R , turns the water-wheel (*rota*) $M R$, and will turn the cog-wheel (*vertebra*) L , and the cylinder or recording barrel $H K$. This [recording barrel], with its teeth regularly disposed on the surface, in accordance with the designs given, will touch each of the levers (*spatulæ*) working on a steel rod $A B$. The levers, being caught by the teeth of the recording barrel, will pull down the 'pallets' (*palmulæ*) of the *abacus claviarius* or 'keys' (*tasti* [= *tacti*]) $E F$, to which they are joined. These being pulled down open 'valves' (*platismatia*), or as the Italians call them, *battiventi*, and thus the wind, forced violently into the 'wind-chest' through the open 'valves,' will enter the organ pipes, and the desired harmony will finally be obtained. . . .

"This automatic construction can be applied not only to organs but also to stringed instruments."

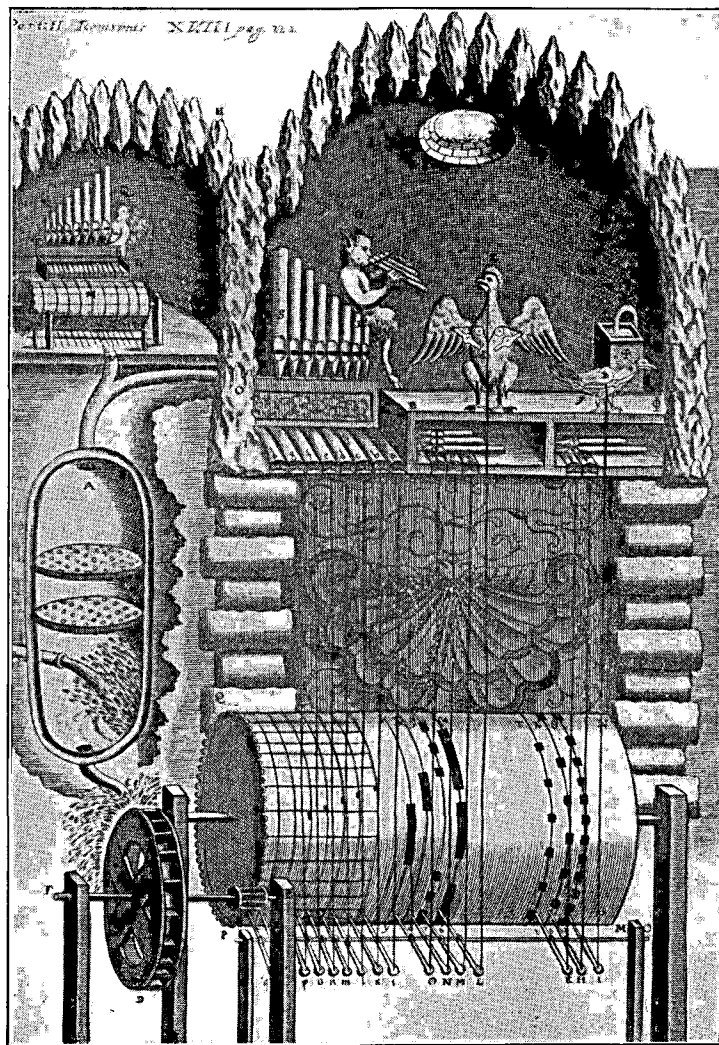


FIG. 16: THE SCHOTT AUTOMATIC HYDRAULIC ORGAN.

Appendix III.

This last paragraph is strangely reminiscent of the Banū Mūsā, who tell us that their instrument could be applied to "the lute or instruments of strings like psalteries."

Kircher also describes more elaborate instruments with dancing figures and wing-flapping birds. A design of one of these instruments is given here (Fig. 15), but it is taken from a certain Gaspar Schott, a cool imitator of Kircher, whose work deserves remembrance on this account.¹

The Banū Mūsā, like Kircher, also allow for "figures which dance and follow this organ," and, strange to say, the Chinese organ "presented by the Muslim kingdoms," "as an offering from the lands of the West," presumably by Hūlāgū to Khubilāi (*ca.* 1260-64), had figures of peacocks on the instruments which "flapped their wings and danced in time with the music."²

¹Schott, G., *Magiæ universalis naturæ et artis, pars II. Acustica* (1657).

²*Journal, Royal Asiatic Society*, April, 1926, p. 193, *et seq.*

BIBLIOGRAPHY.

- Abrahams (I.), *Jewish Life in the Middle Ages*. London, 1896.
 Abū'l-Fidā', *Historia anteislamica, Arabice*. . . . Edit., versione Latina, notis et indicibus auxit H. O. Fleischer. Leipsic, 1831.
Alf laila wa laila. See Macnaghten.
 Apollonius of Perga, *Šan'at al-zāmir*. Brit. Mus. MS. Or. Add. 23391.
 Archimedes, *Alat al-zāmir*. Brit. Mus. MS. Or. Add. 23391.
 Audsley (G. A.), *The Art of Organ-building: A Comprehensive Historical, Theoretical and Practical Treatise on . . . Organs*. 2 vols. New York, 1905.
 Bacon (Roger), *Secretum secretorum*. [Opera hactenus inedita Rogeri Baconi . . . Edit. Robert Steele, Fasc. v.] Oxford, 1920.
 Baluze (E.), *Miscellaneorum libri iv* . . . 4 vols. 1678-83.
 Banū Mūsā, *Waṣf al-ālat illatī tuzammir bināfsihā*. [In *Al-Machriq*, ix.]
 Banū Mūsā. See Hauser (F.).
 Bartolocius (J.), *Tractatus de musicis instrumentis Hebraeorum*. [In Ugolinus, *Thes. ant. sac.*, xxxii.]
Bibliotheca geographorum Arabicorum. Edit. M. J. de Goeje. 8 vols. Leyden, 1870-94.
 Boorhani Qatīu, a *Dictionary of the Persian Language, explained in Persian*; . . . The whole arranged, . . . by Thomas Roebuck. Calcutta, 1818.
 Braunius (J.), *Dissertatio de adolitione suffitus*. [In Ugolinus, *Thes. ant. sac.*, xi.]
 Buhle (E.), *Die musikalischen Instrumente in den Miniaturen des frühen Mittelalters* . . . I, *Die Blasinstrumente*. Leipsic, 1903.
Burhān-i qatī'. See Boorhani Qatīu.
 Bury (J. B.), *A History of the Eastern Roman Empire* London, 1912.
Cambridge Mediaeval History, Planned by J. B. Bury . . . 13 vols. Cambridge, 1902-12.
 Chappell (W.), *The History of Music. (Art and Science.) From the Earliest Records to the Fall of the Roman Empire* . . . London [1874].

- Cheikho (L.), *Catalogue raisonné des manuscrits de la Bibliothèque orientale de l'Université Saint-Joseph, Beyrouth*. [In *Mélanges de la Faculté orientale*, vii.] Beyrouth, 1914-21.
 Coussemaker (E. De), *Scriptorum de musica medii aevi* Edit. E. de Coussemaker. 4 vols. Paris, 1864-76.
 Daremberg (C.) et Saglio (E), *Dictionnaire des antiquités grecques et romaines*. Paris, 1877 et seq.
 Degering (H.), *Die Orgel, ihre Erfindung und ihre Geschichte bis zum Karolingerzeit*. Münster, 1905.
 Didron (A.-N.), *Annales archéologiques, dirigées par Didron aîné*. Paris, 1844 et seq.
 Diels (H.), *Über Platons Nachtuhr*. [In the *Sitz. der . . . Akad. der Wissenschaften zu Berlin*, 1915.]
 Dieterici (F.), *Die Propädeutik der Araber im zehnten Jahrhundert*. Berlin, 1865.
 D'Outrein (J.), *De instrumento magrepha*. [In Ugolinus, *Thes. ant. sac.*, xxxii.]
Encyclopædia Britannica Eleventh edition. 29 vols. Cambridge, 1910-11.
Encyclopædia of Islām. In progress. Leyden, London, 1913 et seq.
 Engel (C.), *The Music of the most Ancient Nations, particularly of the Assyrians, Egyptians, and Hebrews*; . . . Second edition. London, 1870.
 Evliyyā Chelebī, *Siyāhat-nāma*. 6 vols. Constantinople, 1896-1900.
 Evliyyā Chelebī. See Evliya Efendi.
 Evliya Efendi, *Narrative of Travels in Europe, Asia and Africa, in the Seventeenth Century* Translated from the Turkish by Joseph von Hammer. 2 vols. London, 1846-50.
 Farmer (H. G.), *The Arabian Influence on Musical Theory*. London, 1925.
 Farmer (H. G.), *The Arabic Musical Manuscripts in the Bodleian Library*. London, 1925.
 Farmer (H. G.), *Byzantine Musical Instruments in the Ninth Century*. London, 1925.
 Farmer (H. G.), *A History of Arabian Music to the Thirteenth Century*. London, 1929.
 Farmer (H. G.), *Historical Facts for the Arabian Musical Influence*. London, [1930].
 Farmer (H. G.), *The Influence of Music: from Arabic Sources*. London, 1926.
 Farmer (H. G.), *Studies in Oriental Musical Instruments*. London, 1931.
 Farmer (H. G.). See Salvador-Daniel (F.).
 Fétiſ (F. J.), *Histoire générale de la musique depuis les temps les plus anciens jusqu'à nos jours* 5 vols. Paris, 1869-76.
Fihrist, Al-. See Kitāb al-fihrist.
 Fleischer (H. O.). See Abū'l-Fidā'.
 Froehner (W.), *Les musées de France: recueil de monuments antiques*. Paris, 1873.

The Organ of the Ancients.

- Galpin (F. W.), *Notes on a Roman Hydraulis*. [Reprinted from *The Reliquary*, 1904.] London, 1904.
- Galpin (F. W.). See Stainer (J.).
- Gastoué (A.), *Moyen Age. La musique byzantine*. [In Lavignac, *Encyclopédie de la musique*. . . . Tome i.]
- Gastoué (A.), *L'Orgue en France de l'antiquité au début de la période classique*. Paris, 1921.
- Genlis (Stéphanie, Comtesse de), *The Knights of the Swan; or the Court of Charlemagne*. . . . Translated from the French . . . by the Rev. Mr. Beresford. 3 vols. London, 1796.
- Gerbert (M.), *De cantu et musica sacra*. . . . 2 vols. St. Blasien, 1774.
- Gerbert (M.), *Scriptores ecclesiastici de musica sacra*. 3 vols. St. Blasien, 1784.
- Gevaert (F. A.), *La Mélodie antique*. . . . Ghent, 1903.
- Gibbon (E.), *The History of the Decline and Fall of the Roman Empire*. Edited . . . by J. B. Bury. 7 vols. London, 1898, et seq.
- Golijs (J.), *Lexicon Arabico-Latinum*. . . . Leyden, 1653.
- Gwilt (J.). See Vitruvius.
- Hāfiz, *Diwan-i Hafiz*. . . . in Persian . . . Edited by Major H. S. Jarrett. . . . Calcutta, 1881.
- Hājji Khalifa, *Kashf al-zunūn. Lexicon bibliographicum et encyclopædicum*. . . . Edit. . . . G. Flügel. 7 vols. Leipzig and London, 1835-58.
- Hauser (F.), *Über das 'kitab al-hijāl' . . . der Benū Mūsā von . . . Dr. Friedrich Hauser*. [Abhand. zur Geschichte der Naturwissenschaften und der Medizin. . . . Heft I.] Erlangen, 1922.
- Hauser (F.). See Wiedemann (E.).
- Hawkins (J.), *A General History of the Science and Practice of Music*. 5 vols. London, 1776.
- Herōn, *The Pneumatics of Hero of Alexandria, from the original Greek*. Translated for and edited by Bennet Woodcroft. London, 1851.
- Herōn. See Schmidt (W.).
- Heyd (W.), *Histoire du commerce du Levant au moyen-âge. Edition française*. . . . 2 vols. Leipzig, 1923.
- Histoire littéraire de la France*. 29 vols. Paris, 1733-1885.
- Hopkins (E. J.), and Rimbault (E. F.), *The Organ; its History and Construction*. . . . London, 1870.
- Hujwiri, Al- ('Alī b. 'Uthmān), *The Kashf al-mahjūb. The oldest Persian treatise on Sūfism*. Translated by R. A. Nicholson. London, 1911.
- Hunain ibn Ishāq, *Ijtīmā'āt al-falāsifa*. Munich MS. Cod. Mon. arab. 651.
- Hunain ibn Ishāq. See Löwenthal (A.).
- Hunain ibn Ishāq. See Merkle (K.).
- Ibn Abī Uṣaibi'a, *'Uyūn al-anbā' fī ṭabaqāt al-aṭibbā'*. 2 vols. Königsberg, 1882-4.

Bibliography.

- Ibn Ghaibī ('Abd al-Qādir), *Jāmi' al-alḥān*. Bodleian MS. Marsh 828.
- Ibn Khallikān, *Wafayāt al-a'yān*. 2 vols. Būlāq, 1882.
- Ibn Khallikān, *Biographical Dictionary, translated from the Arabic by Baron Mac Guckin de Slane*. 4 vols. Paris, London, 1843-71.
- Ibn Khurdādhbih (Abū'l Qāsim), [Title not given]. Berlin MS. Pm. 173, fol. 1.
- Ibn al-Qiftī, *Ta'rīkh al-hukamā'*. Auf Grund der vorarbeiten Aug. Müller's herausgegeben von . . . Julius Lippert. Leipsic, 1903.
- Ibn Sinā (Al-Ḥusain ibn 'Abdallāh), *Kitāb al-shifā'*. India Office MS. 1811.
- Ibn Sinā (Al-Ḥusain ibn 'Abdallāh), *Rasā'il fī'l-ḥikma*. Constantinople, A.H. 1298 [A.D. 1880].
- Ikhwān al-Ṣafā', *Kitāb Ikhwān al-Ṣafā'*. Edit. by Aḥmad ibn 'Abdallāh. 4 vols. Bombay, 1887-9.
- Isaac of Antioch, *Opera omnia*. . . . Edit. . . . Dr. Gustav Bickell. 2 vols. Giessen, 1873-77.
- Islām, Der. *Zeitschrift für Geschichte und Kultur des Islamischen Orients*. . . . In progress. Strassburg, 1910, et seq.
- Jacob (G.), *Ein arabischer Berichterstatte aus dem 10. Jahrhundert*. . . . Berlin, 1891.
- Jāhiz, Al- ('Amr ibn Bahr), *Majmū'āt rasā'il*. In progress. Cairo, 1324, et seq. [1906].
- Jastrow (M.), *A Dictionary of the Targumim, the Talmud Babli and Yerushalmi, and the Midrashic Literature*. 2 vols. London, 1886-1903.
- Jewish Encyclopædia*. Isidore Singer, projector and managing editor. 12 vols. New York, 1906.
- Kashf al-mahjūb*. See Hujwiri, Al-.
- Khawārizmī, Al- (Muḥammad ibn Aḥmad), *Liber Mafātīḥ al-olūm*. . . . Edit. G. Van Vloten. Leyden, 1895.
- Kircher (A.), *Musurgia universalis, sive ars magna consoni et dissoni*. . . . 2 vols. Rome, 1650.
- Kircher (A.), *Phonurgia nova, sive conjugium mechanico-physicum artis et natura*. Campidona, 1673.
- Kitāb al-fihrist, mit Anmerkungen heraus. von G. Flügel, J. Rödiges, A. Müller*. 2 vols. Leipzig, 1871-72.
- Kohut (A.), *Aruch completum*. 8 vols. Vienna, 1878-92.
- Land (J. P. N.), *Recherches sur l'histoire de la gamme arabe*. [In Actes du sixième Congrès International des Orientalistes tenu en 1883 à Leide.] Leyden, 1883.
- Lane (E. W.), *Madd al-qāmūs. An Arabic-English lexicon*. 8 pts. (vols.). London, 1863-93.
- Lavignac (A.), *Encyclopédie de la musique*. . . . Première partie, *Histoire de la musique*. 5 vols. Paris, 1921-22.
- Leclercq (H.), *Instruments de musique*. [In Daremberg (C.), et Saglio (E.), *Dictionnaire des antiquités grecques et romaines*. In progress. Paris, 1877, et seq.

The Organ of the Ancients.

- Lightfoot (J.), *The Whole Works of the Rev. John Lightfoot, D.D.* edited by the Rev. John Rogers Pitman, A.M. 13 vols. London, 1822-25.
- Löwenthal (A.), *Honein ibn Ishāq, Sinnsprüche der Philosophen. Nach der hebräischen Uebersetzung Charisi's ins Deutsche übertragen . . . von Dr. A. Loewenthal.* Berlin, 1896.
- Loret (V.), *Note sur les instruments de musique de l'Egypte ancienne.* [In Lavignac's *Encyclopédie de la Musique*, I.] Paris, 1921.
- Maclean (C.), *The Principle of the Hydraulic Organ.* [In the *Sammelbände der Internationalen Musikgesellschaft*, vi.] Leipsic, 1906.
- Macnaghten (W. H.), *The Alif Laila, or Book of the Thousand Nights and One Night, in the original Arabic.* Edited by W. H. Macnaghten. 4 vols. Calcutta, 1839-42.
- Machriq, Al-, *Revue catholique orientale mensuelle . . . publ. sous la direction des Pères de l'Université St. Joseph.* In progress. Beyrout, 1898, et seq.
- Mafātih al-'ulūm. See Al-Khwārizmī.
- Mashriq, Al-. See Machriq, Al-.
- Mas'ūdi, Al-, *Les Prairies d'or. Texte et traduction par Barbier de Meynard et Pavet de Courteil.* 9 vols. Paris, 1861-77.
- Merkle (K.), *Die Sittensprüche der Philosophen . . . von Honein ibn Ishāq, der Uebersetzung des Muḥammad ibn 'Alī al-Anṣārī.* Leipsic, 1921.
- Mielziner (M.), *Introduction to the Talmud.* . . . Second revised edition. New York and London, 1903.
- Migne (J. P.), *Patrologiae cursus completus. . . . Accurante J. P. Migne.* 388 vols. Paris, v.d.
- Monumenta Germaniae historica.* . . . Edit. G. H. Pertz. Hanover, 1826 et seq.
- Moule (A. C.), *A Western Organ in Mediaeval China.* [In *Journal of the Royal Asiatic Society*, April, 1926.] London, 1926.
- Mūristus, 'Amal al-ālat illatī ittakhadhahā Mūristus yadhabu šautuhā sittin milān. [In *Al-Machriq*, ix.]
- Mūristūs, *Šan'at al-urghān al-būqī.* British Museum MS. Or. 9649.
- Mūristus, *Šan'at al-urghān al-jāmī' li-jāmī' al-aṣwāt.* [In *Al-Machriq*, ix.]
- Mūristus, *Šan'at al-urghān al-zamrī.* Brit. Museum MS. Or. 9649.
- Oesterley (W. O. E.), and Box (G. H.), *A Short History of the Literature of Rabbinical and Mediaeval Judaism.* London, 1920.
- Patr. Græc.* See Migne.
- Patr. Lat.* See Migne.
- Philōn, *Belopoika.* [In *De la Hire, Veterum mathematicorum Athenaci, Apollodi, Philonis, Heronis et aliorum Opera.*] Paris, 1693.
- Philōn. See Schöne (R).
- Perta Leone (Abraham de), *Šulṭe ha-gibborim.* [In *Ugolinus, Thes. ant. sac.*, xxxii.]

Bibliography.

- Printz (W. C.), *Historische Beschreibung der edelen Sing- und Kling-kunst.* Dresden, 1690.
- Qazwīnī, Al. (Zakariyyā), *Kosmographie.* Heraus. von F. Wustenfeld. 2 vols. Göttingen, 1848-9.
- Rāzī, Al- (Fakhr al-Din), *Jāmī' al-'ulūm.* British Museum MS. Or. 2972.
- Richer, *Histoire de son temps. Texte . . . avec traduction française . . . par J. Guadet.* 2 vols. Paris, 1845.
- Roebuck (T.). See Boorhani Qatiu.
- Rodkinson (M. L.), *New edition of the Babylonian Talmud . . . translated into English by Michael L. Rodkinson.* 20 vols. Boston, U.S.A., 1896-1903.
- Rowbotham (J. F.), *A History of Music.* 3 vols. London, 1885-7.
- Ruelle (C.-E.), *L'Hydraulis.* [In *Darembert et Saglio, Dict. ant. grec. et rom.*, iii (i).]
- Salvador-Daniel (F.), *The Music and Musical Instruments of the Arab, with an Introduction on How to Appreciate Arab Music.* . . . Edited with notes . . . by Henry George Farmer. London [1915].
- Schlesinger (K.), *Is European Musical Theory Indebted to the Arabs? Reply to "The Arabian Influence on Musical Theory, by H. G. Farmer."* London, 1925.
- Schlesinger (K.), *The Organ.* [In the *Encyclopædia Britannica*, 11th edition, xx.]
- Schlesinger (K.), *Researches into the Origin of the Organs of the Ancients.* [In the *Sammelbände der Internationalen Musikgesellschaft*, ii.] Leipsic, 1901.
- Schmidt (W.), *Heron von Alexandria Druckwerke und Automatentheater. Griechisch und Deutsch herausgegeben von Wilhelm Schmidt.* Leipsic, 1899.
- Schöne (R.), *Philonis mechanicae syntaxis libri quartus et quintus.* Berlin, 1893.
- Schott (Gaspar), *Magia universalis naturæ et artis. Pars II. Acustica.* Würzburg, 1657.
- Schwab (M.), *Le Talmud de Jerusalem, traduit pour la première fois.* 10 vols. Paris, 1871-90.
- Schwarzstein (J.), *Targum Arvi. Die arabische Interpretation des Pentateuchs von Rabbi Saadia Hagaon.* . . . Frankfurt-on-Main, 1886.
- Seidel (J. J.), *The Organ and its Construction.* . . . Second edition. London, 1855.
- Seybold (C. F.), *Glossarium Latino-Arabicum ex unico qui exstat codice Leidensi undecimo saeculo in Hispania conscripto . . . edidit . . . C. F. Seybold.* Berlin, 1900.
- Smith (R. Payne-), *Thesaurus Syriacus.* 2 vols. Oxford, 1879 et seq.
- Stainer (J.), *The Music of the Bible.* . . . New edition, with additional illustrations and supplemental notes by the Rev. F. W. Galpin. London [1914].
- Steele (R.). See Bacon (Roger).

The Organ of the Ancients.

- Steinschneider (M.), *Die arabischen Uebersetzungen aus dem Griechischen*. [In *Beihefte zum Centralblatt f. Bibliothekswesen*, v, vii. Leipsic, 1889-93. *Archiv. f. Pathologie*, cxxiv, 1891. *Zeitschrift f. Mathematik, hist.-lit.*, xxxi, 1886. *Zeitschrift d. deutschen morgen. Gesellschaft* lx, 1896.]
- Stokes (W.), and Strachan (J.), *Thesaurus Palæohibernicus. A collection of old Irish Glosses*. 2 vols. Cambridge, 1901-3.
- Talmud Babli. 20 vols. Warsaw, 1859-64.
- Talmud Babli. 10 vols. Amsterdam, 1644-7.
- Talmud Babli. See Rodkinson.
- Talmud Babli. See Wünsche (A.).
- Talmud Yrushalmi. Cracow, 1609.
- Talmud Yrushalmi. See Wünsche (A.).
- Talmud Yrushalmi. See Schwab (M.).
- Tannery (P.), *Athénée sur Ctésibios et l'hydraulis*. [In the *Revue des études grecques*, ix.] Paris, 1896.
- Tannery (P.), *L'Invention de l'hydraulis*. [In the *Revue des études grecques*, xxi.] Paris, 1908.
- Teulet (A.), *Œuvres complètes d'Eginhard . . . traduites en français . . . par A. Teulet*. 2 vols. Paris, 1840-3.
- Theophilus, *An Essay on Various Arts, in three books . . . forming an Encyclopædia of Christian Art of the eleventh century*. Translated . . . by Robert Hendrie. London, 1847.
- Thorndyke (L.), *A History of Magic and Experimental Science*. . . . 2 vols. London, 1923.
- Ugolinus (B.), *Thesaurus antiquitatum sacrarum complectens selectissima clarissimorum virorum opuscula, in quibus veterum Hebræorum mores, leges, instituta, ritus sacri et civiles illustrantur*. . . . 34 vols. Venice, 1744-69.
- Vaux (Carra de), *Le livre des appareils pneumatiques et des machines hydrauliques, par Philon de Byzance*. [In *Notices et extraits des manuscrits de la Bibl. Nat.* . . . xxxviii. Paris, 1903.]
- Vaux (Carra de), *L'Invention de l'hydraulis*. [In *Revue des études grecques*, xxi.] Paris, 1908.
- Vaux (Carra de), *Notice sur deux manuscrits arabes*. [In *Journal asiatique*, Mars.-Avril, 1891.] Paris, 1891.
- Vaux (Carra de), *Notes d'histoire des sciences*. [In *Journal asiatique*, Nov.-Déc., 1917.] Paris, 1917.
- Vitruvius, *De architectura libri decem*. . . . edit. Valentinus Rose et Herman Müller-Strübing. Leipsic, 1867.
- Vitruvius, *The Architecture of Marcus Vitruvius Pollio, in ten books*. Translated from the Latin by Joseph Gwilt. London, 1860.
- Vossius (I.), *De poematum cantu et viribus rythmi*. Oxford, 1673.
- Warman (J. W.), *The Hydraulic Organ of the Ancients*. [In the *Proceedings of the Musical Association*, 1903-4.] London, 1904.
- Wenrich (J. G.), *De auctorum Græcorum versionibus et commentariis Syriacis, Armeniacis, Persicisque commentatio*. . . . Leipsic, 1842.

Bibliography.

- Wiedemann (E.), and Hauser (F.), *Byzantinische und arabische akustische Instrumente*. [In the *Archiv. für die Geschichte der Naturwissenschaften und der Technik*, viii.] Leipsic, 1918.
- Wiedemann (E.), and Hauser (F.), *Über Trinkgefässe und Tafelaufsätze nach al-Jazari und den Benu Musa*. [In *Der Islam*, viii.]
- Wiedemann (E.), and Hauser (F.), *Über die Uhren im Bereich der islamischen Kultur*. [In the *Nova acta. Abhand. der Kaiserl. Leop.-Carol. Deutschen Akad. der Naturforscher*, Band 100.] Halle, 1915.
- Wiedemann (E.), *Über Musikautomaten bei den Arabern*. [In the *Centenario della Nascita di Michele Amari*, 1909.]
- Wiedemann (E.), and Hauser (F.), *Uhr des Archimedes und zwei andere Vorrichtungen*. [In the *Nova acta. Abhand. der Kaiserl. Leop.-Carol. Deutschen Akad. der Naturforscher*, Band 103. Halle, 1918.]
- Woodcroft (B.). See Herön.
- Wünsche (A.), *Der Babylonische Talmud in seinen haggadischen Bestandtheilen übersetzt*. 2 vols. Leipsic, 1886-88.
- Wünsche (A.), *Der Jerusalemische Talmud in seinen haggadischen Bestandtheilen zum ersten Male in's Deutsche übertragen*. Zurich, 1880.
- Wüstenfeld (F.), *Geschichte der arabischen Aerzte und Naturforscher*. Göttingen, 1840.

INDEX TO PERSONS AND WORKS.

Names of works in *italics*.

b. stands for *ibn*.

- before a name or work stands for *Al*.

- A.
- Abaye Nahmani, 41.
- Abba Arika, 26.
- 'Abd al-Qādir b. Ghaibī, 76.
- 'Abd al-Rahmān b. Muḥammad (Abū Zaid), *called* Ibn Khaldūn, 120.
- Abū Ahmad b. al-Rashīd, 57.
- Abū'l-Faraj al-Isfahānī. *See* 'Alī b. al-Ḥusain (Abū'l-Faraj) al-Isfahānī.
- Abū'l-Fidā'. *See* Ismā'il b. 'Alī (Abū'l-Fidā'), *ḥuṣṣan* Abū'l-Fidā'.
- Abū'l-Majd Muḥammad b. Abī'l-Hakam. *See* Muḥammad b. Abī'l-Hakam (Abū'l-Majd).
- Abū Zakariyyā Yahyā al-Bayāsī. *See* Yahyā b. Ismā'il (Abū Zakariyyā) al-Bayāsī.
- Achillini, 124.
- Aelfric, 1.
- Ahmad b. Muḥammad (Abū'l-'Ab-bās) *called* Ibn Khallikān, 87.
- Ahmad b. Mūsā b. Shākir, 87.
- Ahmad b. Muṣṭafā, *called* Tāshkopri Zāde, 77.
- Almad b. al-Qāsim (Abū'l-'Ab-bās), *called* Ibn Abī Uṣaibi'a, 74, 75.
- Ahmad b. 'Umar b. Dusta, *called* Ibn Rusta, 58.
- Aldhelm, 138, 147.
- Alexander the Great, 54, 120, 152.
- Alf laila wa laila*, 74.
- 'Alī b. al-Ḥusain (Abū'l-Faraj) al-Isfahānī, 57.
- 'Alī b. al-Ḥusain (Abū'l-Ḥasan) al-Mas'ūdī, 4, 51, 58.
- 'Alī b. Yūsuf (Abū'l-Ḥasan), *called* Ibn al-Qiftī, 11, 16, 60, 62, 120.
- Amalarius, 147.
- Ameristos, 18, 20.
- 'Amr b. Bahr, *called* Al-Jāhiz, 13, 16, 57, 60.
- Anno, Bishop, 148.
- Apocrypha*, 25.
- Apollinaris Sidonius, 48, 50, 147.
- Apollodoros, 3.
- Apollonios of Perga, 14, 20, 55, 56, 67, 79, 80-6, 114, 115.
- Archimedes, 13, 14, 15, 16, 17, 20, 55, 67, 79, 80-1.
- Aristokles, 3, 4.
- Ariston, Aristū, Aristūn, 12, 17, 20.
- Aristotle, 12, 19, 79.
- Aristoxenos, 3.
- Arsinoe Zephyritis, 15.
- Athēnaios, 3, 4, 11, 15, 38, 41.
- Audsley, G. A., 141.
- Augustine, St., 5, 46.
- Aurelian Reomensis, 155.
- 'Awn b. Muḥammad, 57.
- B.
- Bacon, Roger, 120-4.
- Badī' al-Zamān al-Aṣṭurlābī. *See* Hibatallāh b. al-Ḥusain (Abū'l-Qāsim) al-Aṣṭurlābī.
- Badī' al-Zamān al-Jazari. *See* Ismā'il b. al-Razzāz (Abū'l-'Izz) al-Jazari.
- Baldric, Count, 148, 152.
- Banū Mūsā, 7, 14, 55, 57, 67, 79, 85, 87-118, 164, 166.
- Barker, W. B., 24.

Index No. 1.

- Bar Saroshwai. *See* Henan Isho' bar Saroshwai.
 -Bayāsi. *See* Yahyā b. Ismā'il (Abū Zakariyyā) al-Bayāsi.
 Bennet, 147.
 Bernelinus, or Pseudo Bernelinus, 70.
 Bertinoro, Obadya (Obadiah) de, 35.
 Bertrand de Bar-sur-Aube, 139.
Bible, 1-2, 8, 22, 24.
 -Birūnī. *See* Muhammad b. Aḥmad (Abū'l-Raiḥān) al-Birūnī.
 Budge, E. A. W., 125.
 Burton, R. F., 117.
- C.
Cambridge MSS., 72.
 Cato, Marcus Porcius, 5.
 Cassiodorus, 46.
 Cecilia, St., 8, 9.
 Cicero, 38.
 Chappell, W., 15.
 Charlemagne, 80, 140-44, 148, 149, 152.
 Cheetham, S., 141.
 Cheikho, Père Louis, 70, 151.
 Claudianus, 48.
 Collangettes, M., 88, 106, 114.
 Constantine Copronymus, Emperor, 47, 149.
 Constantine Porphyrogenitus, Emperor, 47.
 Coverdale, Miles, 1.
- D.
 David, King, 8, 9, 78.
 Dallam, Thomas, 78.
 Demaison, L., 139.
 Derenbourg, Hartwig, 151.
- E.
 Eberhard of Freising, 70.
 Eginhard, 148.
 Elias bar Shinaya, 6, 44, 53, 155.
 Ephraem Syrus, 45.
 Euklid, 18.
 Euergetes I, 15.
 Euergetes II, 15.
 Evliyā Chelebi [Evliya Efendi], 3, 77, 78.
- F.
 Fakhr al-Dīn al-Rāzi. *See* Muhammad b. 'Umar (Abū 'Abdallāh) al-Rāzi.
- Fandurūs, 20.
 -Fārābī. *See* Muhammad b. Muhammad (Abū Naṣr) al-Fārābī.
 Felix Monachus, 141.
 -Fihrist, 87, 120. *See also* Muhammad b. Ishāq (Abū'l-Faraj) al-Warrāq, called Ibn al-Nadīm.
 Forkel, J. N., 145.
 Fortunatus, 147.
- G.
 Galpin, Canon F. W., 76.
 Gastoué, A., 45, 153.
 Genlis, Comtesse de, 142-6.
 Georgius Monachus, 141, 152-3.
 Georgius Veneticus, 143, 146, 147.
 Gerbert, l'Abbé, 47.
 Gerbert. *See* Silvester, Pope.
 Gmara, 26.
 Greenwood, J. G., 159.
- H.
 Hāfiz. *See* Muhammad (Shams al-Dīn), called Hāfiz.
 Hājji Khalifa. *See* Mustafā b. 'Abdallāh (Kātib Chelebi), called Hājji Khalifa.
 Hārūn al-Rashīd, Khalif, 80, 139-46, 152.
 -Hasan b. Mūsā b. Shākir, 87.
 Hawkins, Sir John, 32, 36.
 Hedylos, 15.
 Henan Isho' bar Saroshwai, 52, 155.
 Hermes, or Pseudo Hermes, 55.
 Herōn, 15, 20, 38, 40, 52, 55, 56, 79, 80, 115, 119, 127, 135, 149, 151, 156, 159-64.
 Heyd, W., 142.
 Hibatallāh b. al-Husain (Abū'l-Qāsim) al-Aṣṭurlābi, called Badī' al-Zamān al-Aṣṭurlābi, 118.
 Hilāl b. Abi Hilāl al-Himṣi, 14, 56.
 Hippias of Elis, 18.
Histoire littéraire de la France, 139-46.
Holkham Hall MS., 124.
 Hopkins, E. J., 141-4.
 Hosha'yah, Rabbi, 43.
 Huart, C., 142.
 Hucbald, or Pseudo Hucbald, 155.
 Hūlagū, Khān, 75, 76, 167.
 Hunain b. Ishāq (Abū Zaid) al-'Abādī, 52, 57.
 -Husain b. 'Abdallāh (Abū 'Alī), called Ibn Sinā, 73-5.

Index No. 1.

- Husain b. Muhammad (Abū Manṣūr). called Ibn Zaila, 72, 74.
- I.
 Iamblichos, 45.
 Ibn Abī'l-Hakam. *See* 'Muhammad b. Abī'l-Hakam (Abū'l-Majd).
 Ibn Abī Uṣaibi'a. *See* Aḥmad b. al-Qāsim (Abū'l-'Abbās), called Ibn Abī Uṣaibi'a.
 Ibn al-Nadīm. *See* Muhammad b. Ishāq (Abū'l-Faraj) al-Warrāq, called Ibn al-Nadīm.
 Ibn al-Naqqāsh. *See* 'Alī b. 'Isā (Abū'l-Hasan), called Ibn al-Naqqāsh.
 Ibn al-Qiftī. *See* 'Alī b. Yūsuf (Abū'l-Hasan), called Ibn al-Qiftī.
 Ibn al-Zayyāt, Wazīr, 60.
 Ibn Ghaibī. *See* 'Abd al-Qādir ibn Ghaibī.
 Ibn Khallikān. *See* Aḥmad b. Muḥammad (Abū'l-'Abbās), called Ibn Khallikān.
 Ibn Khaldūn. *See* 'Abd al-Rahmān b. Muhammad (Abū Zaid), called Ibn Khaldūn.
 Ibn Khurdādhbih. *See* 'Uбайдalāh b. 'Abdallāh (Abū'l-Qāsim), called Ibn Khurdādhbih.
 Ibn Maimūn. *See* Mūsā b. Maimūn (Abū 'Imrān) al-Qurṭubī, called Ibn Maimūn or Maimonides.
 Ibn Rusta. *See* Aḥmad b. 'Umar b. Dusta, called Ibn Rusta.
 Ibn Sinā. *See* -Husain b. 'Abdallāh (Abū 'Alī), called Ibn Sinā.
 Ibn Zaila. *See* -Husain b. Muhammad (Abū Manṣūr), called Ibn Zaila.
 Ibrāhīm b. Yahyā (Abū Ishāq) al-Naqqāsh, called Al-Zarqālī, 157.
 Ikhwān al-Ṣafā', 74, 137, 155.
 Isaac of Antioch, 48-50, 147.
 Isho' bar Bahlul, 4, 6, 47, 52, 155.
 Isidore of Seville, 147.
 Ismā'il b. 'Alī (Abū'l-Fidā'), called Abū'l-Fidā', 16, 61-2.
 Ismā'il b. al-Hādī, 57.
 Ismā'il b. al-Razzāz (Abū'l-'Izz) al-Jazarī, called Badī' al-Zamān al-Jazarī, 118.
 -Iṣfahānī. *See* 'Alī b. al-Husain (Abū'l-Faraj) al-Iṣfahānī.
- J.
 Ja'far, 142, 144-5.
 -Jāhiz. *See* 'Amr b. Baḥr, called Al-Jāhiz.
 Jastrow, M., 36-7, 43.
 Jem, Prince, 54.
 Jerome, St., or Pseudo St. Jerome, 35.
 Jerome of Moravia, 155.
 Jirjis ('Abdallāh) b. Abī'l-Yāsir, called Al-Makīn, 125.
 Johannes Hispalensis, 121-2.
 John VIII, Pope, 148.
 Jubal, 1, 8.
 Judah al-Harizi, 121.
 Julia Tyrrhenia, 39.
 Julian the Apostate, 38, 46.
 Julius Firmicus, 5.
 Julius Pollux, 38, 40.
 Justinian II, 47.
- K.
 Khubilāi, Khān, 76, 138, 167.
 -Khwarizmī. *See* Muhammad b. Aḥmad (Abū 'Abdallāh) al-Khwarizmī.
 -Kindī. *See* Ya'qūb b. Ishāq (Abū Yūsuf) al-Kindī.
 Kircher, A., 21-2, 32-3, 36, 114, 124, 151, 165-7.
Kitāb al-siyāsa, 120-1, 125-6, 137.
 Ktesibios, 15-6, 19, 39, 128.
- L.
 Larousse, P., 141.
 Lightfoot, J., 35-6.
 Louis le Débonnaire, 119, 143, 147-9.
 Lucretius, 5.
- M.
 Maclean, C., 10, 15, 155, 157.
 -Mahdī, Khalif, 57.
 -Makīn. *See* Jirjis ('Abdallāh) b. Abī'l-Yāsir, called Al-Makīn.
 Maimonides. *See* Mūsā b. Maimūn (Abū 'Imrān) al-Qurṭubī, called Ibn Maimūn.
 Mamerkus, Mamertinos, Mamer-tios, Marmetios, 18.
 Margoliouth, D. S., 18, 37.
 -Ma'mūn, Khalif, 55-7, 87.
 -Manṣūr, Khalif, 54, 141.
 Mar Shmuel, 26.
 Martianus Capella, 48.
 Marzotom, 17.

Index No. 1.

- Marwān, Khalif, 152.
 -*Mashriq*, 141.
 -Mas'ūdī. *See* 'Alī b. al-Ḥusain (Abū'l-Ḥasan) al-Mas'ūdī.
 Mendel, H., 145.
 Midrashim, 24, 43.
 Milton, John, 2.
 Mishnah, 26.
 Moule, A. C., 76.
 Muhammad b. Abī'l-Ḥakam (Abū'l-Majd), 75.
 Muhammad b. Ahmad (Abū Raiḥān) al-Birūnī, 20.
 Muhammad b. al-Ḥasan, 57.
 Muhammad b. Ishāq (Abū'l-Faraj) al-Warrāq, *called* Ibn al-Nadīm, 16, 60, 62.
 Muhammad b. Muhammad (Abū Naṣr) al-Fārābī, 73, 116.
 Muhammad b. Mūsā b. Shākir, 57, 87.
 Muhammad (Shams al-Dīn), *called* Ḥāfiẓ, 76.
 Muhammad b. 'Umar (Abū 'Abdallāh) al-Rāzī, *called* Fakhr al-Dīn al-Rāzī, 12.
 Muhammad b. Yahyā, 57.
 -Muqtadir, Khalif, 80.
 Murtus, Mūristūs, 13, 16-20, 35, 39, 52, 60-70, 127-36, 138, 150.
 Mūsā b. Maimūn (Abū 'Imrān) al-Qurtubī, *called* Ibn Maimūn, 34.
 Mustafā b. 'Abdallāh (Kātib Chelebi), *called* Ḥājji Khalifa, 12, 77, 120.
 -Musta'in, Khalif, 56.
 -Mu'tamid, Khalif, 58.
- N.
 Nahala, 122.
 Nero, 39.
 Nikomachos, 38.
 Notker Labeo, 70.
 Nūr al-Dīn (Zangī), 75.
- O.
 Obtatianus, 38.
- P.
 Papias, 147.
 Paulisa, 20.
 Pépin, King, 47, 141, 149, 151, 153.
 Petronius, 38.
 Pfeiffer, A., 36.
 Philo Judæus, 25.
 Philon, 15-8, 20, 38-9, 55, 79-80, 117, 151.
- Philip of Tripoli, 121-2.
 Plato, 3, 5, 11.
 Pliny the Elder, 15, 38.
 Pommersfelden *Codex*, 70.
 Porphyry, 45.
 Porta Leone, Abraham de, 30-3, 36-7.
 Printz, W. C., 32.
 Proklos, 18.
 Pythagoras, 12, 77.
- Q.
 Qanṭwān, 20.
 Qatāsibiyūs, 19.
 -Qazwīnī. *See* Zakariyyā b. Muhammad (Abū Yahyā) al-Qazwīnī.
 Quintillian, 2.
 Quittard, H., 141.
 Qusṭā b. Lūqā, 56.
- R.
 Rab. *See* Abba Arika.
 Rashi. *See* Solomon ben Yiḥyaq, *called* Rashi.
 -Rāzī, Fakhr al-Dīn. *See* Muhammad b. 'Umar (Abū 'Abdallāh) al-Rāzī.
 Renan, Ernest, 45.
 Ribera, Julián, 76.
 Rimbault, E. F., 141-6.
 Ristūn. *See* Ariston.
 Roland, 152.
 Rowbotham, J. F., 147.
- S.
 Sa'ātūs, 20.
 Salāh al-Dīn, *called* Saladin, 75.
 Schlesinger, Miss K., 9, 23-4, 30, 44, 46, 119, 149-50, 154.
 Schmidt, W., 159.
 Schott, G., 167.
 Schütterus, J., 32.
 Schwab, M., 42, 44.
 Seidel, J. J., 144-5, 149.
 Septuagint, 2, 8, 43.
 Severus, 38.
 Seybold, C. F., 4.
 Shakespeare, 2.
 Shim'on ben Gamaliel, 41.
 Shim'on ben Laqish, 42.
 Shmuel. *See* Mar Shmuel.
 Silvester, Pope, 155-7.
 Smith, R. Payne, 52.
 Smith, W., 141.
 Solomon b. Yiḥyaq, *called* Rāshi, 30, 34, 37.

Index No. 1.

- Stainer, J., 42.
 Stesichoros, 18.
 Steele, R., 120, 124.
 Strabo, Walafriid, 143.
 Stuttgart *Codex*, 70.
 Synesius, 45.
- T.
 Talmud, 2, 8, 24, 38, 41-2, 44, 50, 147.
 Tannery, Paul, 3, 15.
 Targums, 2, 24, 42.
 Tashkopri Zāde. *See* Ahmad ibn Mustafā, *called* Tāshkopri Zāde.
 Tāsītūs, 19.
 Telestes, 2.
 Temistius, 122-3.
 Tertullian, 13, 38.
 Thābit b. Qurra, 14, 56.
 Thales, 18.
 Thāsītūs, Thāstiyūs, 19.
 Themistius, 123.
 Theodore, 147.
 Theodoret, 45-6.
 Theodosius, 46, 70.
 Theophilus Monachus, 70.
 Thorndike, Lynn, 124.
 Trajan, 39.
 Tyndale, 1.
- U.
 Ugolinus, B., 21, 44.
 'Ulayya, Princess, 57.
 Utrecht *Psalter*, 154.
- V.
 Valentinian III, 39.
 Vaux, Baron Carra de, 16, 17, 19, 55, 106, 136.
- Vitalian, Pope, 147.
 Vitruvius, 38, 40, 52, 115, 119, 127, 135, 148-9.
 Voltaire, 139.
 Vossius, 13.
 Vulgate, 1, 2.
- W.
 Wang chung wên kung chi, 76.
 -Wāthiq, Khalif, 60.
 Warman, 11, 13, 155.
 Wiedemann, E., 63, 70, 98, 107, 152.
 William of Malmesbury, 156-7.
 Wolfram von Eschenbach, 140.
 Woodcroft, Bennet, 159.
 Wulstan, 138.
 Wünsche, A., 44.
 Wyclif, 1.
- Y.
 Yahyā b. Abī Mansūr, 87.
 Yahyā b. Ismā'il (Abū Zakariyyā) al-Bayāsī, 75, 117.
 Ya'qūb b. Ishāq (Abū Yūsuf) al-Kindī, 73.
 Yāyastayūs, 19.
 Yüan shih, 76.
 Yuhannā b. al-Baṭriq, 19, 120.
- Z.
 Zakariyyā b. Muhammad (Abū Yahyā) al-Qazwīnī, 151.
 -Zargālī. *See* Ibrāhīm b. Yahyā (Abū Ishāq) al-Naqqāsh, *called* Al-Zargālī.
 Zosimos, 13.

INDEX OF MUSICAL INSTRUMENTS AND TECHNICAL TERMS.

- A.**
Abbuba, 49.
Alā, 127, 128, 135. See *Ar[c]a*, *Tannūr*.
Ar[c]a, 52, 127, 135. See *Alā*, *Tannūr*, *Bōmiskos*.
Arcula, 115. See *Rukba*.
Auloi, 161.
- B.**
Bāb maṭḥūn, 100, 102. See *Pallet*.
Bagpipe, 9.
Bankām, 157. See *Klepsydra*.
Barbiton. See *Ma'āzif*.
Bell, 29, 36. See *Cymbalum*, *celcal*.
Bithūn, 66. See *Epistomium*.
Bōmiskos, 52, 127, 135, 160. See *Ar[c]a*, *Alā*, *Tannūr*.
- C.**
Celcal, 29. See *Bell*, *Cymbalum*.
Cervicula, 115. See *Ung*.
Cheirorganon, 5.
Chithara, 4. See *Cithara*, *Qītār*, *Qithara*.
Cithara, 48. See *Chithara*, *Qītār*, *Qithara*.
Cphunutha, 48. See *Symphonia*.
Cymbalum, 27. See *Mçiltaim*.
- D.**
Duff, 157. See *Tambourine*.
Dulcimer, 54. See *Psanter*.
- E.**
Epistomium, 166. See *Bithun*.
- F.**
Flute, 29, 32, 54. See *Halil*, *Nāy*, *Shabāb*, *Shabbāba*, *Ṣaffāra*.
- G.**
Gurgrana, 41.
Ghinā', 6, 69.
- H.**
Habba, *habbat al-muṣawwita*, 85, 92, 94, 105, 112-3, 116. See *Sound-box*.
Haçereth, 27. See *Trumpet*.
Halil, 29, 32. See *Flute*.
Hannāna, 117.
Harp, 1, 8, 27, 54. See *Jank*.
Hedhrula, 6, 44, 48, 52. See *Hydraulis*.
Hirdabulis, 41. See *Hirdaulis*, *Idrablis*.
Hirdaulis, 38, 41-2. See *Hydraulis*.
Horn, 29, 49. See *Qarna*, *Shophar*.
Hsing lung shêng, 76.
Hydraulic Organ, 3, 4, 13-5, 79-118, 165-7.
Hydraulis, 2-21, 35, 38-44, 48-53, 119-38, 143-57, 159-64.
- I.**
Idrablis, 38. See *Irdablis*, *Hirdaulis*.
Infundibulum inversum, 115, 127. See *Pnigeus*, *Unbūb*.
Iqā', 75, 88, 105. See *Rhythm*.
Irdablis, 42. See *Idrablis*, *Hirdaulis*.

Index No. 2.

- J.**
Jank 'ajamī, 74. See *Harp*.
- K.**
Kennara, 49. See *Lyre*, *Kinnor*.
Kettledrum, 36. See *Timpanum*.
Keys, 166.
Kinnor, 27. See *Kennara*, *Lyre*.
Klepsydra, 12-4, 17, 80. See *Ban-kām*, *Water-clock*.
Korablin, 43.
Kurra, 91-2.
- L.**
Lahn (melody, music), 68-9.
Linguae, 46. See *Sliders*.
Lute, 167. See *Ud*.
Lute strings, 111-2.
Lyre, 27. See *Kinnor*, *Kennara*.
- M.**
Ma'āzif (sing. *mi'zafa*, *mi'zaf*), 107, 117. See *Psaltery*, *Barbiton*.
Magrephah, 25-38, 44.
Mashroqitha, 22.
Mausul, 157.
Mçiltaim, 27.
Megiston organon, 5.
Minim, 2.
Mizmār, 3, 69, 94, 116-7, 157.
Mughannā, 6.
Mukhannath (pl. *mukhannathūn*), 6, 44.
Musical Tree, 139-40.
- N.**
Nagham, 69.
Nauba, 108.
Nāy, 14, 69, 80, 85, 110, 157.
Nāy tatārī, 74.
Nebel, 27. See *Harp*. *Tunbūr*.
N'imah, 42.
- O.**
Organon, *Organum* (a pipe), 1-3; (stringed instrument), 4-5; (generic term), 5; (species of composition), 6.
- P.**
Pallet, 100, 102. See *Bāb maṭḥūn*.
Piano, 2. See *Psanter*.
Pipe, 1-3. See *Zamr*, *Surnāy*, *Mizmār*, *Abbuba*.
Plinthion achordon, 5.
Plinthion auleichon, 6, 41.
Pneumatic Organ, 7-11, 21-38, 46-8, 54-73, 139-57.
Pnigeus, 127, 135-6. See *Infundibulum inversum*, *unbūb*.
Psalmos, 1.
Psalterion, *Psalterium*, 1, 4.
Psaltery, 74. See *Psalterion*, *Qānūn*.
Psanter, 2. See *Piano*.
- Q.**
Qānūn miṣrī, 74. See *Psaltery*.
Qarna, 49. See *Horn*.
Qītār, 2. See *Cithara*.
Qithara, 48. See *Qītār*.
- R.**
Rabāba, 157.
Rebec. See *Rabāba*.
Regal, 146.
Rhyton, 15.
Rhythm. See *Iqā'*.
Rotta, 4.
Rukba, 91, 115. See *Sölēn plagion*.
- S.**
Ṣaffāra, 14, 117. See *Flute*.
Shabāb, *Shabbāba*, 53, 157. See *Flute*.
Shāhrād, 157.
Sha'ira, *Sha'irat al-mizmār*, 66, 116, 133, 136. See *Habba*.
Shir, 29.
Shophar, 29. See *Horn*, *Qarna*.
Sliders, 46, 72, 136, 162.
Sölēn plagion, 115. See *Rukba*.
Sound Box. See *Sha'ira*, *Habba*.
Surnāy, 69, 92, 98, 100-1, 105, 108-10. See *Mizmār*.
Symphonia, 48. See *Cphunutha*.
Syrinx, 39-40.
- T.**
Tabla, 41.
Tambourine, 54. See *Duff*.
Tannūr, 52, 135. See *Alā*, *Ar[c]a*.

Index No. 2.

Tarkīb, 69-70, 73. See *Organum*
(species of composition).

Timpanum, 4. See *Kettledrum*.

Trigonon, 3.

Trumpet, 27. See *Ḥaçoçereth*.

Tunbūr, 157.

U.

'*Ud*, 75, 107, 110. See *Lute*.

'*Ud jilliḡi*, 74.

'*Ugab*, 1-2, 8, 42.

Unbūb, 64, 127, 135. See *pnigeus*,

Infundibulum inversum.

'*Unq*, 91, 115. See *Cervicula*.

W.

Water-Clock. See *Klepsydra*, *Ban-*
kām.

Water-Organ. See *Hydraulis*.

Wind-Chest. See *Rukba*.

Z.

Zammāra, 44.

Zamr, 14, 75, 80, 88, 104, 107.

Zemara, 47.

Zimri, 44.

Ziqq, 64, 107, 129.

Ziqq rūmī or *zauḡi*, 127, 131.

ERRATA.

Page 23, line 35.—For "*The Organ*, 3" read "*The Organ*, 4."

„ 24, „ 25.—For "reveal" read "reveals."

„ 34, „ 31.—After "(d. 1200)" add "Idelsohn (*Jewish Music*, 496) says,—'*Magrephah* is derived from *grophith* reed.'"

„ 38, „ 1.—For "or hydraulic organ" read "or to the hydraulic organ."

„ 48, „ 8.—For "Apollinarus" read "Apollinaris."

„ 50, „ 21.—After "century" add "There is the well-known diptych of Anastasius of Constantinople (A.D. 517), which may represent an *hydraulis*, but we cannot be sure that these diptychs represent contemporary manners and customs. As in the contorniates, there is a tendency to copy earlier designs."

„ 55, „ 24.—For "Apollonius" read "Apollonios."

„ 56, „ 2.—For "Qusṭa" read "Qusṭā."

„ 56, „ 4.—For "Apollonius" read "Apollonios."

„ 64, „ 28.—For "ibn Muḡaffar" read "ibn al-Muḡaffar."

„ 70, „ 9.—For "Bernelius" read "Bernelinus."

„ 73, „ 21.—After "enquiry" add "In the section on mechanical instruments in his *Iḡṣā al-'ulūm*, known in Europe as *De scientiis*, Al-Fārābī refers to mechanical instruments of music, which would include the various kinds of organs."

„ 76, „ 33.—For "158" read "157."

„ 83, „ 13.—For "Wiedermann" read "Wiedemann."

„ 116, „ 15.—After "with" add "what appear to be."

„ 117, „ 5.—Delete bracket after "*ḡannānāt*."

„ 118, „ 1.—For "Aṣṭurlābī" read "Aṣṭurlābī."

„ 124, „ 25.—For "has" read "have."

„ 136, „ 14.—For "*ḡisṭ*" read "*aḡsāṭ* (sing. *ḡisṭ*)."

„ 142, „ 33.—For "14" read "18."

„ 143, „ 29.—For "translations" read "editions."

„ 151, „ 6.—After "that" add "works by."

„ 169, „ 25 and 27.—For "Evliyyā" read "Evliyā."

BY THE SAME AUTHOR.

The Arabian Influence on Musical Theory.
2s 6d. (1925).

The Arabic Musical MSS. in the Bodleian Library. 3s. (1925).

The Influence of Music: from Arabic Sources.
3s. 6d. (1926).

A History of Arabian Music to the Thirteenth Century. 15s. (1929).

Historical Facts for the Arabian Musical Influence. 12s. 6d. (1930).

Studies in Oriental Musical Instruments.
7s. 6d. (1931).